

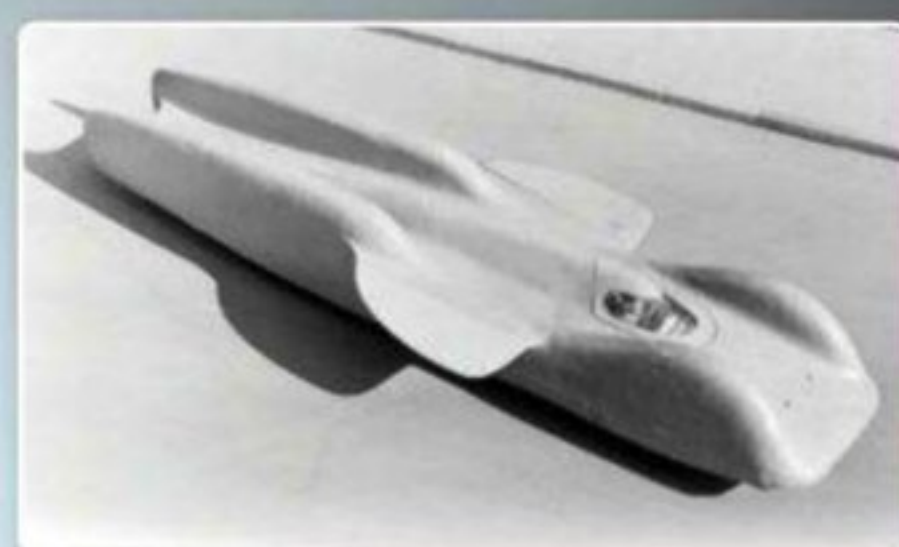
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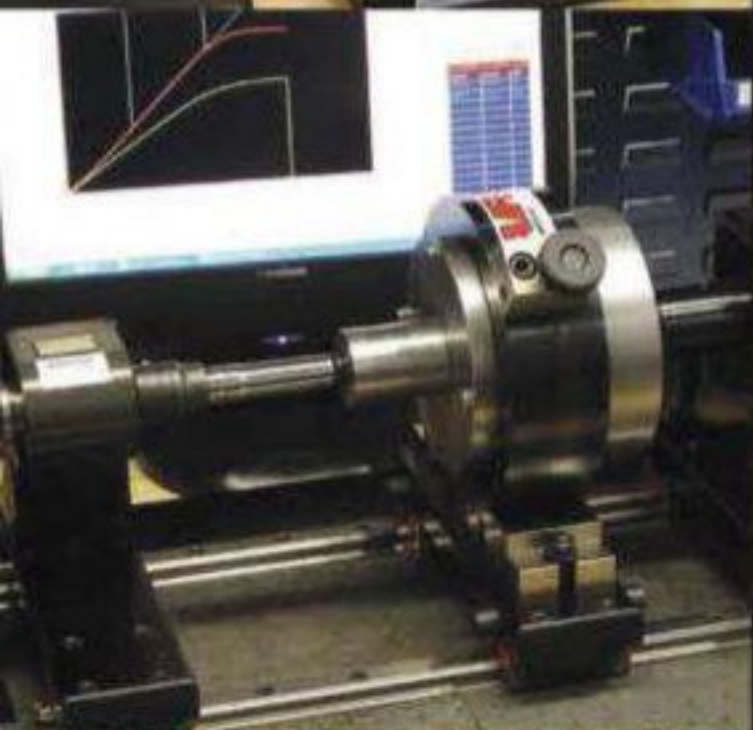
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Crystal ball gazing

Chris Aylett says that there is high demand for engineering talent

This season has been a great year for many in motorsport. The World Rally Championship is attracting the attention of several 'new' automotive brands, the British Touring Car Championship has closed on a record year with larger TV and trackside audiences, 'historic' racing booms across the world, F3 continues to produce full grids and GT and Sportscar grids have been larger than ever, right across the range.

In fact, there is now a shortage of top-class engineers in the UK with companies struggling to recruit. Demand is so strong, with confidence for the future, that employment in motorsport is booming. One bright idea to tackle this problem is TRS - check this out at www.talentretention.biz - a free scheme to re-employ top engineers laid off from the UK defence industry.

Talking of defence, those companies that diversify outside motorsport are now seeing real benefit. They balance their reliance on motorsport by securing business in defence, automotive, marine and even space. Margins are good and importantly, most are long-term contracts, giving a level of security not found easily in motorsport. More should look at taking their skills and technology into other sectors, and get diversification underway right away. The MIA leads various programmes doing just this, helping companies to reach new markets - never an easy task without help.

As we end 2011, the future becomes ever harder to predict. The major markets for motorsport are Europe and the USA, both of which are in economic turmoil. This atmosphere can affect corporate and personal confidence, which has a direct knock-on effect on the financial plans needed for motorsport.

Yet all indications are that business will remain strong. One thing is for sure, decisions are likely to be made even later than in 2011, which can really stretch suppliers.

By the time you read this, the major European and US motorsport shows will be behind us, so we will have a clearer idea of business prospects in 2012

leaders behind energy efficient motorsport attend this event to exchange views and see the latest developments. Both Lord Drayson and Lord Green, the UK Trade Minister, will speak, as will Azhar Hussain of TTxGP and Nick Fry of the Mercedes GP team, amongst others.

2012 and 2013 will undoubtedly see continued

Dinner, with famous referee, Graham Poll, entertaining us on Thursday night - you would be very welcome.

Unless the economic storm damages our plans even further, my belief is that the next two years are going to be really exciting. With new products, new series and exciting new technologies to witness, whether it's electric racing with the 850bhp Lola / Drayson, the Delta Wing at Le Mans, EFI in NASCAR Sprint Cup or the NGTC - there's plenty to entertain our customers and create new opportunities for business and sponsorship.

Let's pray for a Christmas gift that the politicians can clean up the mess in Europe and the USA and give us all a genuinely happy and prosperous New Year ahead. Come and say hello at the Autosport Show in the MIA Business Lounge (Stand 8020), and good luck for 2012. www.the-mia.com



"More should look at taking their skills and technology into other sectors"

in these important markets, and still have Autosport International ahead to look forward to in the early new year.

The MIA will, once again, bring together businesses interested in a low carbon motorsport future at our Low Carbon Race Conference on Wednesday 11 January. The

and growing interest in 'energy efficient' solutions from electric through hybrids, to new fuels. This remains a productive area for new business.

Come and meet the MIA during the Autosport show - perhaps bring friends to enjoy our Business Excellence Awards



Series such as the British Touring Car Championship have proven popular in 2011 to competitors and spectators

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Enough is sufficient

Innovation and the death of downforce. Hopefully

Progress stagnates without innovation, and without progress economies stagnate. Even where innovation is present, it may become circular, in the sense that it supports only itself. Aerodynamic downforce, perhaps like Tamara Ecclestone's TV show, is famous for being famous, but serves few needs outside its own small circle.

The era of wings has been great fun, but enough is more than sufficient. After nearly 50 years of 'aero this' and 'aero that', motor racing has surely wandered sufficiently far down the pointless cul-de-sac that is downforce.

For readers of tender years, one should mention that before the mid-1960s aerodynamic research was aimed at reducing drag - useful work that led to road car improvements in function and style. Consumer car manufacturers realised they could make better looking cars with lower fuel consumption and quieter noise signatures by paying more attention to aerodynamics.

Following the discovery of downforce, however, racing engineers parted company with volume car-making engineers, who had no use at all for downforce. The racing engineers then rushed headlong down what has become one of the most pointless design paths in engineering history.

The original downforce genie was let out of the bottle by the 1966 Can-Am Chaparral 2E which, with its monstrous rear wing, cast a long shadow that still hovers like a pall over most classes of motor racing. Worshipped for their innovation, which was nevertheless to become as evil an addiction as heroin, American citizens Hall, Mrlik, Musser and Winchell, under the protection of General Motors, filed the definitive US patent, entitled 'Aerodynamic Spoiler for Automotive Vehicles' in 1967.

Nearly five decades later, zillions of dollars have been spent on super-computers, wind tunnels and mathematical modelling to make cars stick to the track with downforce created by derivatives of those early 'Aerodynamic Spoilers', but it was not only aerodynamics they spoilt.

For the fans, increasing downforce has meant less interesting racing. Cars cannot approach each other, let alone overtake because they lose front grip in turbulence from the car in front. The Formula 1 situation became so bad that driver skill was substituted by the goal of

enough to warrant additional downforce, for safety or any other reason.

In Formula 1 the madcap rush to achieve pointlessly faster lap times, including the double whammy of a secondary cul-de-sac development in the form of downforce generated by ground effect, came at the expense of recognisable competition, and so caused the FIA to search for a solution. Mr Ecclestone helpfully suggested artificial rain to reduce grip, but the FIA eventually decided on the now familiar Drag Reduction System (DRS), where a rear wing

following car, whereas previously the FIA has taken pains to ensure sporting rules apply equally to all cars. To compound matters, the DRS antidote has no useful road car equivalent either, although its inverse - raising a wing to create drag for emergency braking - is being seriously researched.

The wider problem with downforce development is that it is a converging field of interest only to motor racing, and not to the wider business community from which motor racing receives its cash. The best motor racing developments are those with divergent possibilities that help spawn widespread business activity. McLaren has a spin-off business using composite skills and Williams has a transmission spin-off business, but few, if any, outside of motor racing will want to buy 'downforce' as a product.

In refreshing contrast, the energy conservation systems of KERS / ERS have already taken root and caused widespread non-racing investment at firms like Flybrid, Ricardo and the like. These are fruitful development areas that can seed new UK firms to help the economy, conserve energy and hopefully re-kindle a technical engineering interest in motor racing that seems to have been drained by the search for, aptly named, down-force.

It is no surprise that the king of downforce, Red Bull's Adrian Newey, is thought by many to have compromised his own 2011 Formula 1 KERS system in order to make a better aero package. It is moves like that which cause the author to fervently hope that the legacy era of Mr Newey *et al*, brilliant though it was, is now drawing to a close. The future of motor racing needs to be about competitive performance, driven not by a plethora of wobbling wings that other cars keep tripping over, but by the most intelligent team and driver application of primary energy. 

"one of the most pointless design paths in engineering history"

more downforce for better lap times. For what purpose? No one cares about lap times. People pay to see sport entertainment from close competition, not a line of cars hoping to overtake at some artificial, rule-induced pit stop.

Every penny and every second of the work on 'negative lift' has been wasted, as no consumer car gets to travel on public roads fast

on a following car can be flattened to decrease drag and increase speed sufficiently to overtake the car in front. Crucially, however, the leading car is not allowed to use DRS to defend against the move. So pernicious an evil has downforce become then that motor racing has stooped to adopt an asymmetric sporting rule that only applies to a



The downforce genie that started it all - the 1966 Can-Am Chaparral 2E



8 www.racecar-engineering.com • January 2012



owners

car but it did not put Breedlove off, and he rebuilt the car over the winter.

His next attempts were to be on Black Rock in 1997, at the same time as Wing Co Green was trying to break the sound barrier in Thrust SSC. The Thrust team knew Sonic Arrow was easily capable of 700mph, and probably more. In fact, John Ackroyd, the designer of Thrust 2 and a consultant to Breedlove, had plotted the performance of the car on the day it suffered the crash and calculated that it was capable of at least 850mph.

But, despite its clear potential, the American challenge was brought to a grinding halt by a

small bolt ingested by its primary 'hot' General Electric J-79 jet engine. After installing the spare engine, the afterburner of which wouldn't light, Breedlove gave up for the year and passed all of his remaining time allocation on the desert to Thrust SSC. Green went on to drive the English car to a new outright World Land Speed Record of Mach 1.01 / 763.035mph.

Breedlove spent the next nine years looking for the budget to return to Black Rock with a re-designed car, but ultimately decided to sell the project to record setting adventurer and one time racing driver, Steve Fossett. Fossett's plan was to use

Breedlove's project as the basis for a new attempt at the outright World Land Speed Record.

So, in mid-2006, Sonic Arrow began its transformation into the Fossett LSR. The work was carried out by a team of engineers headed by aviation expert Eric Ahlstrom, and the project's working title clearly set out the goal - Target 800mph.

'The first thing we did when we got the car was corrosion control,' recalls Ahlstrom. 'It had been in a bad environment in a shop that had flooded.'

'It is important to understand that the car was stripped when we got it. A lot of it was on the shelf, the engine was out and

almost nothing was documented. Ultimately, it was far less complete than we had been led to believe. We went on to rebuild about 90 per cent of the car. It would be akin to taking a 10-year old Formula 1 chassis and turning it into a current Le Mans car, with all of the bodywork and drivetrain changes that entails.'

The basic vehicle concept was retained, along with the steel tube frame chassis with stressed aluminium skin. The wheelbase and rear track were both extended by 3ft. The intake position and shape were left unchanged and the single J-79 jet engine layout was also kept. (It is interesting at this point to note



Rear view showing off the wider track and structural changes to the rear suspension and parachute fittings as well as the revised wheel fairings

that Craig Breedlove's own 2014 project is a twin-engine design.)

One of the first areas that Ahlstrom's team focussed on was what they felt caused the 1996 crash. 'Looking at the data from the tests we decided we would have to look at the steering system and the steering geometry,' he explains. 'It seemed to us that this is what caused the issues at Black Rock. So to test the steering we simply hauled the car out into the parking lot and pushed it at a whopping 5mph. It didn't steer. It was completely unstable. So we re-designed it until it was stable and self-correcting. On top of that, we found and fixed five other flaws that would have caused an accident at over 700mph. That was probably the most

the test programme, and the first thing on the schedule was low-speed testing of the steering and braking systems. We would run in increments starting at 200mph and working our way up. At each increment we would have tried to turn the car. We had equipped it with GPS, attitude, accelerometer and wheel load sensors and we would rapidly turn the car from side to side with the response of the car vs the demand of the driver monitored. If there was an instability, we would hopefully find it at low speed before finding out at high speed, as Breedlove did. It is funny because in land speed racing nobody seems to test the steering - just mentioning this part of the test programme to other teams alarmed them. They

"It is funny... in land speed racing nobody seems to test the steering"

extensive and difficult part of the project. We were proceeding down a path and we thought we had something that was working but, when we got into it, we discovered it was not working and we had to back right up.

'Around the time of Steve's death we were about to enter

just presume that as the car is going straight that everything is fine. Had Thrust SSC not had steering issues they would not have done steering tests either.'

When Breedlove lost control at Black Rock, many put the problem down to aerodynamic instability, and it was no surprise that the



The cobalt-chromium 'Flintstone' skid brake proved good for -0.26g at any speed. Note there is almost no wear after 20+ runs

Fossett team made substantial modifications to the bodywork of the car with that in mind. But Ahlstrom maintains that actually aerodynamics were not the root cause of the issue: 'The idea of an aerodynamic instability was absolutely preposterous to us. Everyone outside the team thought it was an aerodynamic issue, but CFD was performed in late 1996 that showed no lifting of the back end and that the design was highly stable. The whole concept is focussed around drag vs stability, which is quite unlike any other competition car. Everywhere else designers are restricted by rules that are trying to keep the car slower and slower, until you reach a point like they have in F1 where all of these tiny things become critical. If you

look at the aerodynamics for a road vehicle they will focus on downforce to generate traction and, as a result, there is not a single aerodynamically stable vehicle on the road today. At 1000mph we don't have that traction requirement, the only thing we have to do is go straight and not fly!'

AERODYNAMIC RE-WORK

With this in mind, the aerodynamic re-work of the Fossett LSR gave rise to a very different looking vehicle, somewhat reminiscent of the never-built Bluebird CN8.

'The vertical stabiliser that was on the car originally was well forward of the rear wheel fairing, and the stabiliser is only as effective as its area multiplied



TECH SPEC

ENGINE: S&S LM-1500 / J-79

Supplied by: S&S Turbine Services Ltd

Fuel capacity: 105 gallons

Thrust: 18,750ft.lb (83.4kN / approx 37,500bhp) with afterburner and water injection

Oil capacity: 2.5 gallons

CONSTRUCTION:

Steel tube frame with stressed aluminum skin
Carbon / Kevlar / glass fibre composite driver capsule, engine inlets, and rear wheel fairings

Tyres: filament-wound carbon / glass composite material with rubberised epoxy matrix

Wheels: aluminum billet hub; special alloy spun disc heat treated; steel fasteners

Wheel bearings: tapered rollers

Suspension / front: coilover hydraulic shocks

Suspension / rear: variable deflection beam

Steering: worm and sector

Parachutes: mortar deployed; supersonic capable

Windscreen: Lexan

Electrical power: deep cycle batteries, 28V system

The Fossett team installed aerospace grade hard line and fire-sleeved all wiring harnesses, note the chassis frame



The office: a very basic cockpit shows the new emergency fuel shut off and all controls moved to the yoke (steering wheel)



Hybrid aluminum wheel-CFRP, tyre-FGRP cap, showed high durability. A set of 1300+ mph wheel assemblies comes with the programme.

by its distance from the c of g. On Breedlove's design it was too weak to work at supersonic speed as it was right next to the c of g. It was essentially just billboard space. If you look at the Breedlove car, it had scallops in the rear wheel fairings, so we basically just filled those in and that eventually increased the area of the wheel fairings. That more than made up for the loss of the vertical stabiliser.'

During the runs at Black Rock, Thrust SSC experienced something never before encountered by a car - the supersonic shock wave. Images of the car racing across the desert revealed huge waves ahead of the car, and distortions in the air around it. The blunt, cut-off bodywork around the jet nozzles

was causing expansion shocks to mix the jet thrust with playa dust, leading to buffeting of the tail section. This led to the car taking a severe punishing, with panels being torn off the rear of the body. In addition, the staggered rear wheels would have their individual transonic shock waves merge at just under 600mph resulting in an abrupt turn and a very 'sporty' ride for Wing Co Green. It was these same 'compressibility' forces that were first experienced by Luftwaffe pilots in the rocket-powered Me163 Komet fighter 'plane in the Second World War and, later, that were responsible for the death of Geoffrey de Havilland jr in the de Havilland DH 108 Swallow jet research aircraft. In addition to violent buffeting, pilots reliant

on hinged aerodynamic surfaces for control found their aircraft controls non-responsive as they reached high Mach numbers, and it was not until the Bell X1 was fitted with a 'flying tail', similar to that planned for the stillborn Miles M.52, eventually followed by the application of German-lead research into swept wings, that the transonic problems were countered. The 'sound barrier' was, and is, a real thing and it lies right in the middle of the region where both Thrust SSC and the Fossett LSR would have to run in, though at this point in time, according to the FIA, only one of them is a true supersonic vehicle.

'It is important to separate two things in a dynamic sense, Thrust SSC was not a supersonic vehicle, despite its name (SSC

stood for Super Sonic Car), it was a transonic vehicle,' explains Ahlstrom. 'The transonic region starts below the speed of sound, where some of the flow starts to go supersonic over the vehicle and this starts to cause what we call supersonic boundary layer separation. This drag problem was the sound barrier that was spoken of in the early days of supersonic vehicles. As you accelerate through Mach 1 these areas of separated air are filled in by supersonic flow and, somewhere between Mach 1.1 and 1.30, the entire vehicle is enveloped in supersonic flow and that separation goes away. In a transonic region we have both the wake and the separation to deal with. Because of this, most modern aircraft cannot actually

fly at Mach 1. They can do up to about 0.97 but then the drag falls and they accelerate right through Mach 1 and do not slow down until they get to Mach 1.05 or faster.

'There are two ways of dealing with the shock waves on different parts of the car. One is to design a vehicle that is very sensitive to them, to be hyper critical about every point in the design and eliminate all of the problem areas. That's the way Ron Ayers does things. Breedlove, on the other hand, went in a different direction and decided to develop a vehicle benign to these forces and not worry too much about them. The guys I work with from Boeing and from Stanford feel that this is the best approach. I think there are areas on Thrust SSC that could have been re-shaped so that they would not have had these problems.'

The sheer speeds involved in this record attempt make the mind boggle, but so do the other forces the vehicles have to contend with. When the Bell X1 broke the sound barrier it just had to contend with the aerodynamic forces. A supersonic car, on the other hand, has to contend with the planet itself, so that part of the Fossett LSR had to be made

bulletproof, and other parts must push materials beyond their natural limits.

'When you consider this car weighs 9700lb (4409kg), when driving across the desert at over 700mph the loads on the wheels are enormous, and critical. At 1000mph, a 900mm diameter wheel runs at about 9500rpm and has around 45,000g of hoop stress. There is not a natural material on the planet that can take those loads, only man-made composites. Including significant stress contribution from the

special carbon fibre tyre around the edge. Our analysis showed they are probably good for between 1300-1400mph.'

BULLETS FROM A GUN

Foreign object damage (FOD for short) stopped Sonic Arrow first time around and it was a critical consideration in the wheel design on the Fossett LSR. 'We are travelling faster than a bullet, so it's very important to think about impact resistance. If the vehicle is hit by anything at this speed it is essentially being hit by a bullet.

"there is not a single aerodynamically stable vehicle on the road today"

wheel disc, aluminium is only good for 800mph, titanium maybe 1100mph, when we count its sensitivity to notch stress and fatigue. I don't know what all of the other teams are smoking, but you can't do this with a metal, the load, the mass and the damage requirements are just too high. Breedlove saw this a long time ago and they came up with a great solution - a hybrid wheel with an aluminium centre and a

Even with the whole course having been 'fodded' (when teams on foot remove potential FOD-inducing rocks from the course by hand) there are still a lot of small rocks under the surface at a depth of 1-10mm. It is likely that the wheels will hit them from time to time. With metal you're literally cutting a notch in it, and that can cause a stress concentration, which leads to a crack and may end up causing catastrophic

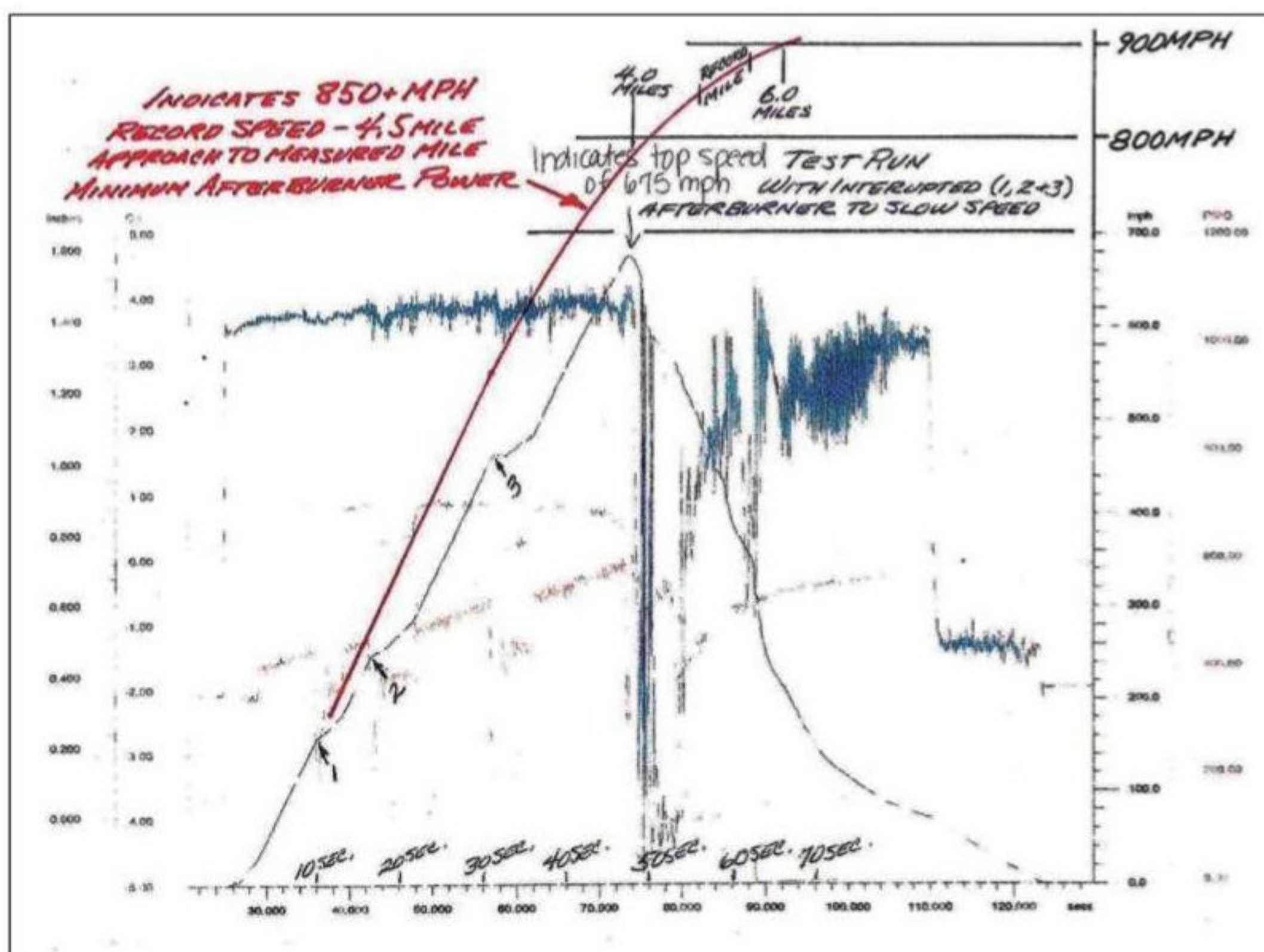
failure. Breedlove had used woven fibreglass as a sacrificial surface layer in his tyre design, and the first set held up beautifully for nearly 20 runs between 1996 and '97, including two at over 600mph. We have reinforced anything that may take a direct hit from a rock with stainless steel, but overall the car does not need a lot of armour plating. Most of it only takes glancing blows, but the wheel wells take horrible impacts so we planned on those sections to be easily replaceable. They're sitting there essentially with bullet-proof vests on!

Once a car has achieved such high speeds, of course it also has to stop again before it runs out of space, as Breedlove once did in the 1960s at over 500mph (in sequence: parachute failure; brake failure; telephone pole; dyke; brine-filled ditch; swim away). Initial braking for the Fossett LSR from 800mph+ is, in fact, achieved by parachutes adapted from Cold War-era 'lob-toss' nuclear bomb drogues. At lower speeds, you would expect to turn to the experts in stopping vehicles at high speed when facing such a challenge, but Breedlove did something quite unlikely - he turned to a company that makes medical implants. Sonic Arrow's unusual braking system is a big piece of serrated metal that is hydraulically shoved into the desert floor at 300mph. 'It's a remarkably good idea and is one of the best features of the car. It is made of cobalt-chromium, a particular alloy that is used in medical implants.

'Avoiding the use of wheel brakes has the advantage that the skid brake works at any speed. The best point about it, though, is that we have no chance of locking a wheel and flat spotting it as we brake from 300mph down to zero. There were rumours saying it didn't work, but I've got the telemetry printouts that show it worked perfectly and, in fact, is far better than any wheel braking system on these cars.'

FURTHER UPGRADES

Ahlstrom went on to explain that he had been thinking about further upgrades to the car that could help it reach even higher speeds, and a three-year plan,



The data from the 1996 run showing acceleration at ~90% throttle, wobble, roll, parachute deployment, and skid braking. The performance projection was added by Thrust 2 designer John Ackroyd

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SIMON MCBEATH TALKS SUPERSONIC TO RON AYRES

The speed of sound in air, Mach 1 or $M = 1.0$, is not a fixed thing. It depends primarily on absolute temperature. In dry air at 20degC (68degF) it is 767.8mph, but at lower temperatures it is less. It can be calculated approximately according to the relationship:

$$\text{speed of sound (mph)} = 44.841 \times \sqrt{T}$$

Where T is the absolute temperature in degrees Kelvin (20degC = 293K).

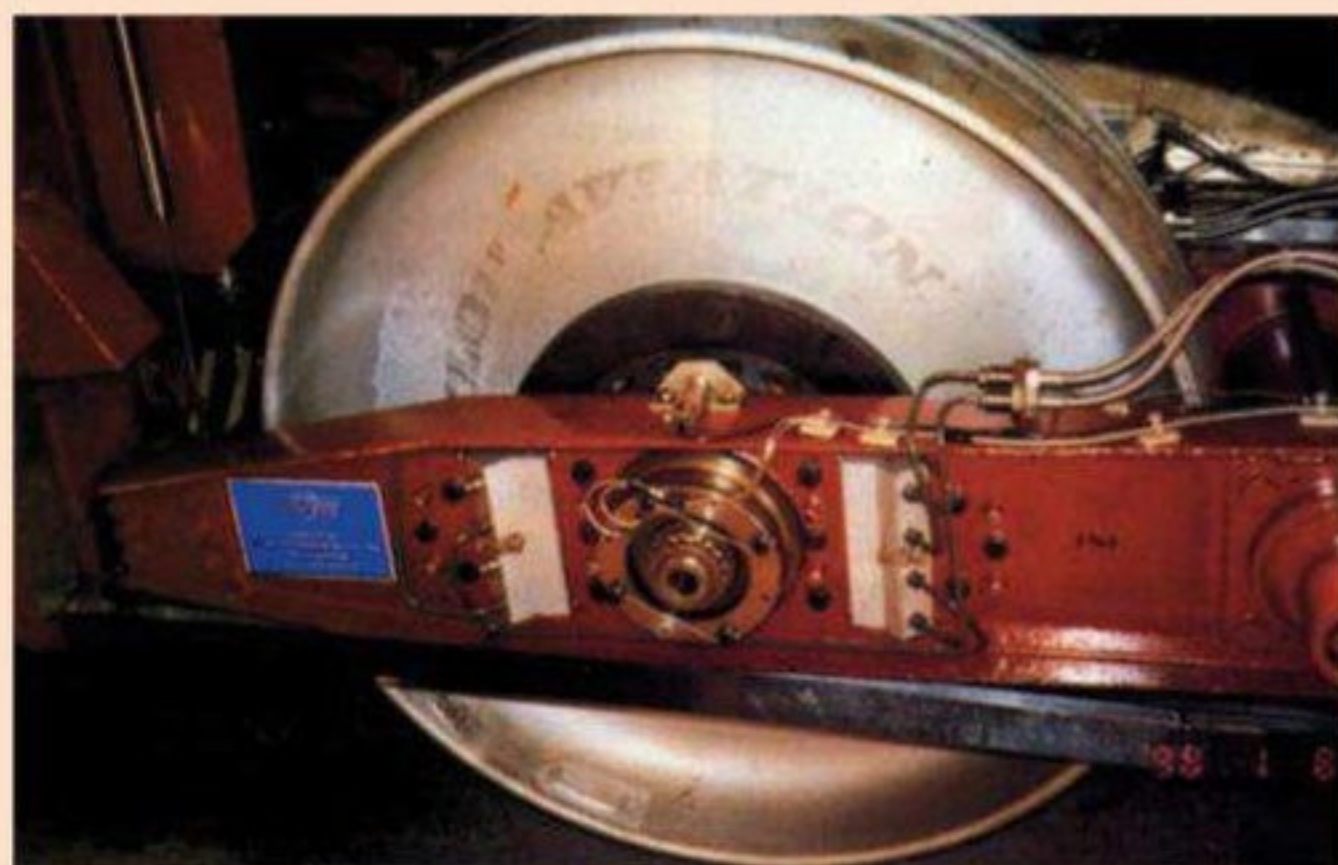
The Thrust SSC (TSSC) team was understandably keen that going supersonic should be accurately and faithfully recorded, so great trouble was taken to ensure the necessary data and facts were obtained. Ron Ayers: 'TSSC exceeded $M = 1.0$ on both runs, and we have the FIA certificate to prove it. The FIA representatives at Black Rock Desert were extremely thorough and, quite correctly, gave us no latitude.

'In order to record Mach number, the speed of sound had to be established for each run. A precise recording thermometer was mounted at the centre of the measured mile. Other thermometers around the track confirmed that there were no significant temperature gradients that may mislead the scrutineers. The temperature was then recorded as the car traversed the measured mile for each run. The Mach number was computed for each run, and the average taken. Both runs were supersonic, and the average was Mach 1.02. The peak velocity recorded on either run was 771mph which, at the prevailing temperature,

corresponded to a Mach number of 1.03. The record was set early in the day and the temperature was less than 15degC, so the speed of sound was lower than the figure computed for 20degC.

'As we, and the FIA, were in totally uncharted territory I felt it necessary to ensure that we agree a definition of the word 'supersonic'. We badly wanted that word on the final record certificate and did not want it omitted because of inadequate definition. I pointed out that a new FIA World Land Speed Record is set when the previous record is exceeded by not less than one per cent. By extension, it seemed reasonable that we could claim to have gone supersonic if the car exceeded $M = 1.00$ by not less than one per cent. As such, the region between $M = 1.00$ and $M = 1.01$ should perhaps be called 'sonic', but above 1.01 we could claim was 'supersonic'. The FIA agreed to this definition.

'The FIA team also had to ensure the car was in contact with the ground throughout the measured mile. As shock waves had trashed the desert surface for the full 3.6m width of the vehicle, the wheel tracks were completely invisible. However, if we dipped our hands into the fluidised bed, we could tell where the wheels had been as they fluidised the surface about 15cm more. The [FIA] team went on hands and knees down the length of both tracks to feel for this evidence of contact and to satisfy themselves we had not done any 'low flying''



Thrust SSC's metal wheels dug into the Black Rock desert at high speed causing Andy Green to lose control at one point

including engine and aerodynamic upgrades, could, he says, have seen the car pushed as far as 1050mph, in theory.

And with all of the initial updates on the car largely complete, the plan was to run for the record in 2008 at a central Nevada dry lake bed known as Diamond Valley. Surveys, permits and other paperwork were all in process. But, on September 3, 2007, Steve Fossett took off in a borrowed Bellanca Super Decathlon light aircraft to fly over

Today it sits in a hangar in Reno, Nevada, exactly as you see it in these photographs, with all of its essential support equipment included in the sale.

With the outright World Land Speed Record having risen from double figures to the cusp of 800mph in its first 100 years, it might be hard to see how much higher it can go. But remember, the first aircraft to exceed Mach 1 was in 1947 and Mach 2 (around 1300mph) was realised only

"on September 3, 2007, Fossett took off over the Sierra Nevada mountains. He never returned"

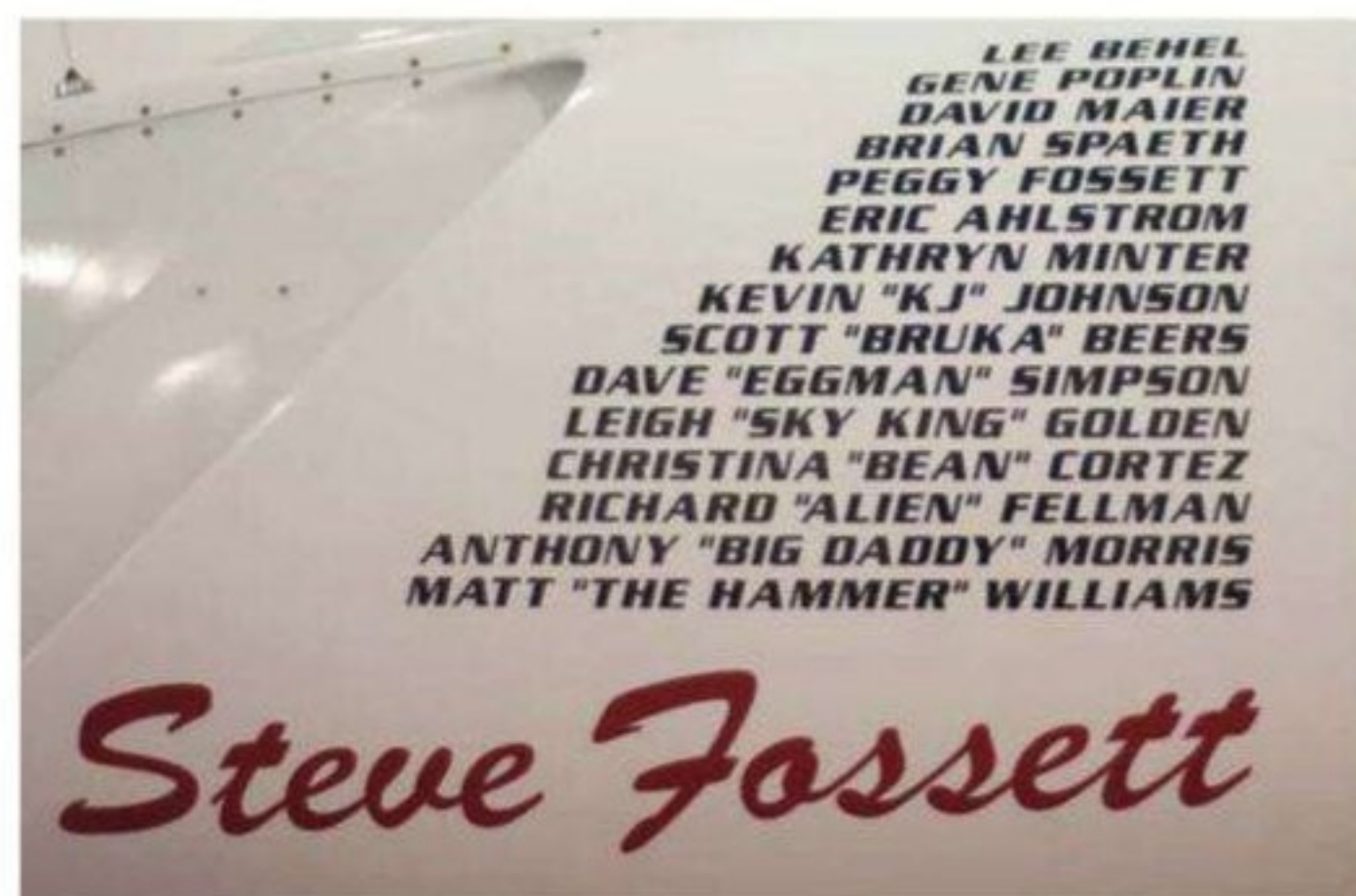
the Sierra Nevada mountains on a pleasure flight. He never returned.

The entire Target 800 project was kept active for several months but, in early 2008, it was mothballed and later placed up for sale for \$3m, an incredibly low price when you look at the budget of Bloodhound SSC. 'We are all aviation professionals and we essentially pickled everything when the project stopped,' explains Ahlstrom. 'Everything was packed up very carefully and left in a perfect condition. We stored it in such a way that we could re-start the project in a very short space of time.'

Long-time Fossett record collaborators Project 100 Communications (project100.com) are responsible for finding the car a new home.

six years later, and Mach 3 just three years after that. With the inspiration of ram-jet engined experimental aircraft such as the Lockheed Aurora and NASA's X43A UAV already capable of hypersonic speeds, could the new breed of supersonic cars go even faster still? Most of the current challengers are already targeting the 'marquee number' of 1000mph. Some even higher. Of course, to get to 1000mph you first have to get to 800mph, and then 900mph.

The key issue for going even faster may not be the cars at all, but the course upon which they run. The question is, is there anywhere big and flat enough on the surface of the earth to go a lot faster? Well, if development of wheel technology eventually permits running on hard salt, there is this desert in Bolivia... 



Steve Fossett's work ethic and goal focus were an inspiration to everyone who worked with him

known from pole to pole



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Target: 1000mph

With at least half a dozen World Land Speed Record projects currently in existence, the race is on to go supersonic...



It doesn't seem like 14 years since Thrust SSC achieved the biggest single incremental increase in the history of outright land speed record (LSR) when it reset the mark of its predecessor, Thrust 2. Thrust SSC raised the record

for the measured mile from 633.47mph to 763.035mph, and was the first vehicle to go supersonic in the process, achieving an average of Mach 1.02.

Now the race is on to raise the record again, and the current global level of activity in this

endeavour is unprecedented, with teams from Australia (two), Great Britain (one), New Zealand (one) and the USA (two, one jointly Canadian) declaring their intent to either simply move the record upwards or, in the case of some, to aim for the

astonishing speed of 1000mph, whilst keeping all wheels firmly attached to the ground. In addition, the Fossett project is covered in detail elsewhere, but here we take a look at the others, starting with the only one that has already done some running.

"Thrust SSC raised the record from 633.47mph to 763.035mph"



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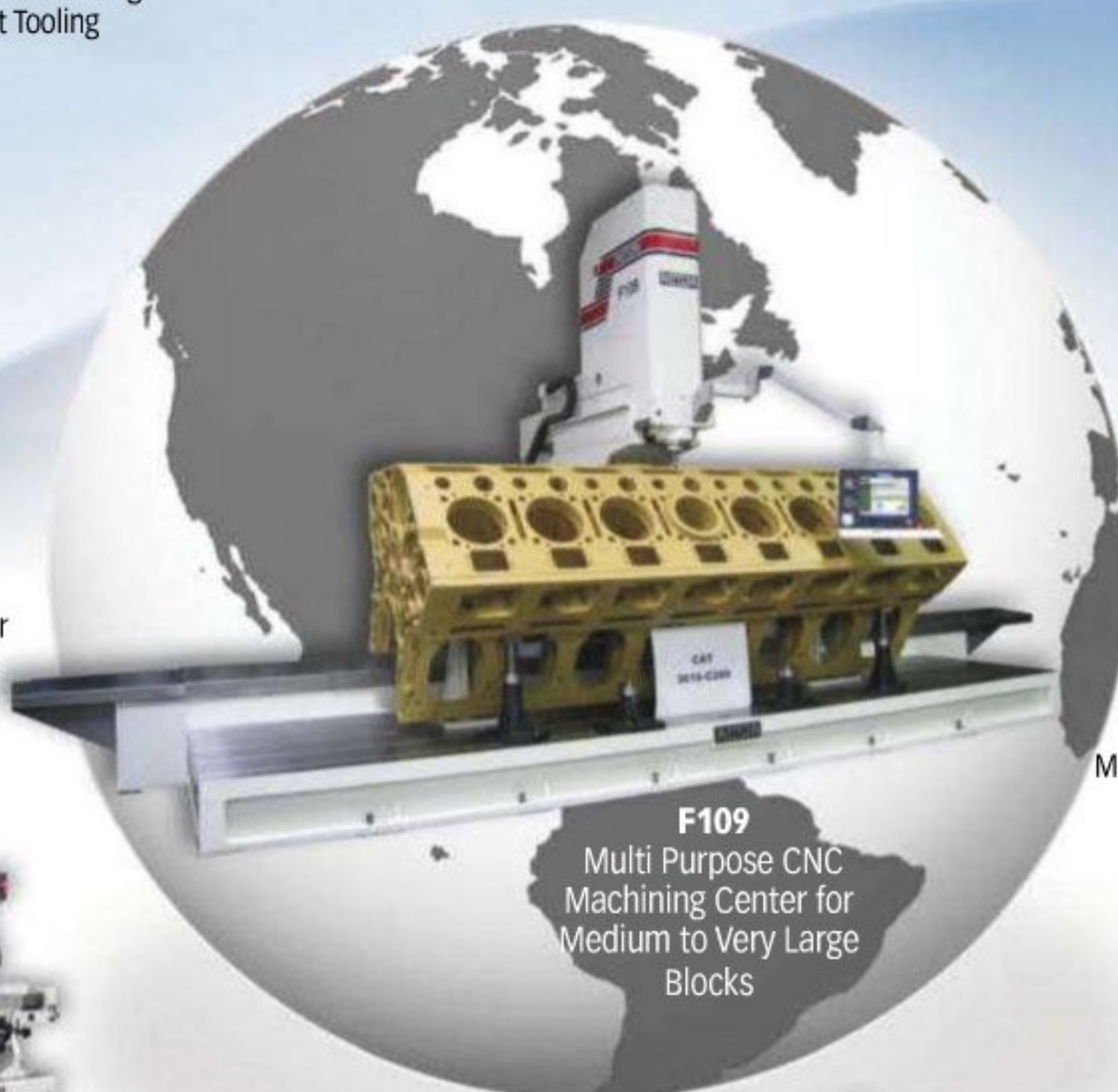
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North American Eagle

The North American Eagle land speed racer has already run at speeds of 400mph and, on that basis alone, must be regarded as one of the most likely contenders to break the current world record first. The aim is to do that and go on to 800mph. But, as with all the current projects, it's all going to come down to finance.

The principal personnel in this joint USA / Canadian adventure are project manager and driver, Ed Shadle, and director of operations Keith Zanghi, who are backed up by a team of 40-odd volunteers who donate large chunks of their free time to maintain progress. The project began in 1999 when Shadle and Zanghi bought a scrap Lockheed F-104 'Starfighter' jet fighter fuselage, which forms the basis of their design. The obvious temptation is to think the crew expected to just pull the wings off, bolt some wheels on and, because the Starfighter was capable of supersonic speeds in the air, that it would be a simple matter of repeating that feat on the ground. But nobody on the team ever thought that simplistically, and there certainly seems to be an atmosphere of pragmatic realism running through the team's approach.

So just what was required to convert the airframe into a ground vehicle? Shadle explains: 'an F-104 fuselage had some benefits but also some downsides. The benefits were aerodynamic streamlining by the best in the business. The inlet design was also perfect for our mission so we didn't have to design inlets that would prevent a compressor stall as we approached supersonic speeds. The downside was figuring out how to support the fuselage and build a suspension that worked.'

CHASSIS AND SUSPENSION

'After much head scratching,' Shadle continues, 'I figured out that if I placed a spacer plate between the tail cone and the

fuselage, I could anchor the rear suspension to that. Steve Green at Eagle Machine in Canada made a 3/4in (19mm) T1 steel plate in the shape of the round fuselage with a hole in the middle large enough to fit the engine through. An extension was also cut at the bottom that extended down far enough to attach a beam that would hold the rear axle. The plate was fastened solidly to the fuselage and attachments were made to hang the tail cone. From there we created the rear suspension parts and set the rear axle width at 11ft 6in (3505mm).

'For the front suspension we gutted the front landing gear bay and altered the internal stringers so we had a smooth wall. We built a steel box that would fit snugly up inside that cavity with a locating pin and two bolts to keep it in place. We built a front wheel carriage that pivots at the front and is steered with hydraulic cylinders at the rear. The front suspension is hydraulic / gas cylinder with overload springs with 2in (50.8mm) travel at the axle.

'With a long wheelbase, it was necessary to prevent flex in the fuselage, so we sandwiched two steel plates to each side of the keel beam where the main landing gear was previously mounted. We installed Torflex axles through the beam and made them adjustable for loading. We add about 500lb (2230N) of load on the mid-wheels to keep the body from flexing.

'We also had to fill in the wing roots, so we used dense foam then layered it with Kevlar and fibreglass mat. We screwed the perimeter down every two inches then finished it and sanded it to a mirror finish.'

WHEELS

Because of the high rotational speeds encountered at Mach 1 and above, wheel design comes in for detailed consideration. Shadle: 'For early testing we built our system around rubber tyres. But we spent about a



year designing and building the high-speed wheels. We first had to understand the stresses on the wheels in three different applications. The nose wheel had to be designed with some steering authority, so we built two keeps on the wheel, and it also had to take side load. It is 24in (610mm) diameter and 7in (178mm) wide. The mid-wheels would be 20in (508mm) diameter and 4in (102mm) wide but will

run at higher revs, and the rear wheels would be 34in (864mm) diameter and 6in (152mm) wide. The rear wheels are built with three concave 'valleys' in order to resist side slip.

'The rear wheels also have the brakes installed, so special attachment points had to be figured into the design. Using 7076-T6 forgings was the answer as the modulus of elasticity met our requirements.



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LAND SPEED RECORD CONTENDER - USA

We did have to come up with a unique method of interfacing the bearings to the aluminium wheels. The FEA conducted by our team physicist indicated that the growth at 800mph of a 3in (76.2mm) diameter centre hole would be about 0.017in (0.432mm). That meant that a pressed-in bearing race would loosen and probably destroy the wheel. We therefore had to build a 4340 steel insert into the aluminium wheel and encase the bearing race into the steel. Using SKF 15 degree angular contact bearings with Kluber grease, we were set to go. We've now run the wheels up to 400mph and feel confident that our next testing at 600mph will prove that we are safe beyond 800mph.

'We recently made a couple of changes to the front wheel. First we took it to Victor Aviation and had it cryo-treated. We then installed double sets of bearings in the nose wheel for added insurance that they will stay intact at roughly 12,000rpm.'

SLOWING DOWN

The choice of an F-104 allowed the team to utilise the existing air brakes mounted on each side of the waist of the fuselage, which were designed to take the forces at speeds up to Mach 1.8.

The wheel brakes, however, are an intriguing part of the development. Shadle elucidated: 'Using LEV X technology, we built magnet packs that slide on rods out to within 1/8in (3.2mm) of the rotating brake discs. Using permanent magnet technology, we can generate 1550 braking horsepower off each rear wheel when the magnet packs are activated, yet no braking resistance exists when the brakes are retracted to rest. There are 27 neodymium iron boron magnets in each brake pack. The 28th pocket takes an infrared temperature sensor to monitor brake disc temperature. The discs themselves are made from 1.5in (38mm) thick forged aluminium and cooled with pressurised water sprayed onto them while engaged.

'The parachutes are hand made from nylon and Kevlar. They are pressure packed into a deployment bag that is stuffed



General Electric J-79 Turbojet engine produces 18,780lb of static thrust

into two stainless steel 'chute cans. A button on the instrument panel picks a relay that pulls a solenoid to release the door on the 'chute cans. As that door opens, it picks a micro switch that fires an air charge and blows the deployment bag into the air stream behind the vehicle. As all 15ft (4.57m) of multi-strand

and lubrication systems and afterburner in our hangar. Our engine volunteers, Bill Eckberg, Sean Rondesvedt and Cam Shadle, got it all together for successful testing by S&S Turbine Services in Fort St John, British Columbia. Robin Sipe and Al Vanholan [at S&S] are two of the best GE J-79 engine experts

"We can generate 1550 braking horsepower off each rear wheel"

plasma riser line plays out to full length, the bag strips off the 'chute and allows it to stretch out. The pilot 'chute that assists the deployment stays attached to the deployment bag via a tag line. As the 'chute reaches full stretch, the reefing line retainers begin to separate and the 'chute is allowed to blossom. As the high-speed 'chutes are only 8.3ft (2530mm) diameter, the forces on the riser line remain within the 51,000lb (227kN) strength of that line. We've tested the 'chutes to 400mph with superb results. We also tested the magnetic brake system with no support from the speed brakes or parachutes and they also worked perfectly.'

ENGINE

As if to illustrate that projects such as these aren't all plain sailing (no pun intended) Shadle related the tale of early engine running: 'We started off with a surplus General Electric J-79-11B engine. We assembled the gearboxes, ignitors, fuel

in the world. After the tests were completed, we installed the engine in the airframe.

'Our initial engine runs in the North American Eagle proved to be a bit of a disaster as we discovered an afterburner feedback cable had a pinch in the housing that caused the turbine blades to overheat and the engine spat out the blades. So we upgraded the hot section and solved the feedback cable problem. Since then we have run the engine many times with no bad results. In 2010, S&S sent us a new afterburner section and the engine now puts out a static 18,780lb of thrust.' And demonstrating that land speed record racing is no different to any other branch of motorsport when it comes to retaining competitive advantage, Shadle remarked, 'We do have a few other tricks up the sleeve, but won't divulge those at this time...'

North American Eagle has also created its own data acquisition system. Strategically located

sensors include strain gauges, accelerometers and other sensors, including air pressure. 75 input channels sample at a rate of 3.5 million Hz into a system that captures the data and inputs that to a Lenovo computer with an Intel solid state drive, water cooled to deal with the desert and operational heat. There is also an onboard uninterruptible power supply to keep the system functioning when the engine is shut down after a run.

'Steve Wallace, our data acquisition engineer, also built a network of antennas using a wireless Ethernet system so that all data from the 12-mile run can be transmitted to a base station. For positioning information, we use a Tropos GNS (Global Navigation System) that pinpoints our position within 0.20in (5mm) up to 1000mph.

The North American Eagle team began testing in 2005 and, since then, has carried out nine test sessions and completed 31 runs at various venues, including Black Rock Desert, Nevada, where Thrust SSC set the current record. Shadle describes the project as 'close to being finished', saying, 'We want to conduct one more test session to validate our CFD, steering and rate of acceleration and deceleration, then we can set a firm date for our attempt at the record.' If the team can secure the necessary funding, that could be as soon as autumn 2012. 

TECH SPEC

North American Eagle
(www.landspeed.com)

Length: 56ft (17.07m)

Weight: 13,700lb / 6227kg dry

Chassis: 1957 Lockheed F104A-10 Starfighter fuselage with NAE designed suspension and systems

Engine: GE LM-1500 turbojet developed by S&S Turbine Services Ltd

Thrust: 18,780lb (83,742N)

Wheels: solid forged aluminium by Eagle Machine Co

Braking: Lockheed air brakes; Drumheller Engineering parachutes; magnetic wheel brakes

Bloodhound SSC

Richard Noble's latest land speed record project got underway in 2005, and the current schedule is to complete the rolling chassis by the end of 2012 so testing can begin in 2013. Project director Noble, continues to maintain support and funding, while chief engineer is now Mark Chapman, after previous engineering director, John Piper, left to pursue F1 interests. Ron Ayers, veteran of Thrust SSC and JCB Dieselmax, remains chief of aerodynamics and Wing Commander Andy Green, the current land speed record holder in Thrust SSC, is once again the driver.

After roughly three years of research, the basic aerodynamic package was finalised in April / May 2010, with a shape that was stable throughout the speed range (up to 1050mph). While

refinements of course continue, this meant manufacture of the main chassis structure (in conjunction with aerospace manufacturer, Hampson Industries) could commence and work on integrating the Cosworth CA 2010 F1 engine that serves as the auxiliary power unit (APU) begin. James Painter, engineering lead - vehicle integration: 'Our focus has been on the rear chassis, which is very much a geodesic structure with metallic panels and comprises three main parts - the lower chassis, the rear subframe (which carries the rear suspension) and the top section (from which the jet engine hangs). This area is the responsibility of Brian Coombs and Roland Dennison. And the design of this obviously had to be firmed up in sufficient detail to allow drawings to be released to Hampson. A lot of

thought went into the lower chassis because it incorporates the mounts for the jet fuel tank and the rocket, and it includes the aperture through which the Cosworth APU is installed. And now this major section is in manufacture, so that represents significant progress.'

Racing Batteries provide onboard starting power for Bloodhound's fuel pump. With no off the shelf starter solution available, Dr John Davis and his team had two challenges; to select a suitable starter motor, and to find the lightest batteries possible.

Initial calculations suggested that around 40kg of lead acid batteries would provide the necessary power, the team recognised that adopting lightweight lithium technology could make a significant contribution to performance.

A number of key components

of Bloodhound are to be made in composite, under the eye of F1 and LMP composite designer, Stuart Allen. UMECO ACG, better known as Advanced Composites Group, is manufacturing the nose, monocoque, jet engine intake and wheel fairings. Painter: 'In terms of composite manufacturing, the target of having a rolling chassis ready by the end of 2012 dictates that the main structures, including the monocoque, need to be bolted together around September.'

ENGINES

Dr Davis is now 'embedded' at Cosworth, working on the rocket control system that, as well as driving the HTP (high test peroxide, the rocket oxidiser) pump, also supplies hydraulic pressure for the air brakes and

the HTP control valves. 'Cosworth have given great support,' related Painter, who is responsible for, among other things, integration of the APU and the design of the gearbox that connects the engine to the HTP pump. This gearbox contains Xtrac gears running in a machined-from-billet casing currently being made with the assistance of Jaivel and Newburgh Engineering. It connects to the Cosworth engine via an AP Racing carbon clutch. The gearbox actually fulfils five roles: it reduces rotational speed from the engine's 18,000rpm to 11,000rpm for the HTP pump; it provides a means of starting the APU via an ARK Racing starter and ring gear; it provides hydraulic power; it has a dog clutch to engage with the APU pump; and it enables the clutch to de-couple the gearbox from the APU if required.

All of this work is tied into the next series of rocket engine tests. In August 2011, a 6in (152mm) version of the Falcon hybrid rocket was successfully fired, but now a sequence of validation tests are planned in

which the full size 18in (457mm) rocket will be run using the APU, gearbox and pump, the HTP tank and its nitrogen pressurisation system. In other words, most of the rocket system that will run on the finished vehicle.

INTEGRATION

One of the main challenges has been with packaging, as Painter expanded: 'There were quite a few elements to take into account with the Cosworth APU alone. For example, we have to meter the air to the inlet because, at higher Mach numbers, there is considerable ram effect. Also the stagnation temperature can be 130-140degC at the intake, which no race engine is going to like! The location of the APU exhaust was critical too for, as speed goes through the transonic region, shock waves move along the fuselage so we had to ensure the APU's exhaust didn't emerge where there are high-pressure areas. It now locates in a low-pressure region under the car. And then there's the need to access the APU, especially at the start of a day's running and during the mandatory one-hour maximum turnarounds between record attempt runs. These are things we have to think

through now to ensure good serviceability.'

Recent aerodynamic developments posed some potential challenges to the vehicle's layout, too. A Design of Experiment programme fixed the rear lift problem that became apparent following the switch around of the jet and rocket engines, but there was still the unacceptable yaw stability problem to deal with. With the major masses unable to move significantly in order to move the c of g forwards, the only other option was to move the lateral centre of pressure rearwards, which was achieved by increasing the tail fin size (but not its width). Interestingly, this actually had the additional benefit of reducing drag.

Work is also ongoing on the suspension systems and the jet fuel tank. Painter is working with Jonathan Tubb at Advanced Fuel Systems on the details.

Project director Richard Noble also reported in his August 2011 online diary that the design team was working on weight saving because the car had become heavier than planned. With the proposed venue for the record attempt, Hakskeen Pan, offering just a 12-mile (19km) track length, time will tell if this weight gain can be cut or indeed whether it is critical to the mission.

TECH SPEC

Bloodhound SSC

(www.bloodhoundssc.com)

Length: 44ft (13.4m)

Weight: 6422kg (14,158lb) fuelled

Chassis: steel spaceframe and carbon composite

Engines: Rolls Royce EJ200 jet engine; Falcon Project hybrid rocket motor; Cosworth CA2010 F1 engine

Thrust: 47,543lb (212kN) combined

Wheels: 900mm, aluminium, v-section

Braking: air brakes (800mph); twin parachutes (600mph); friction brakes (200mph)



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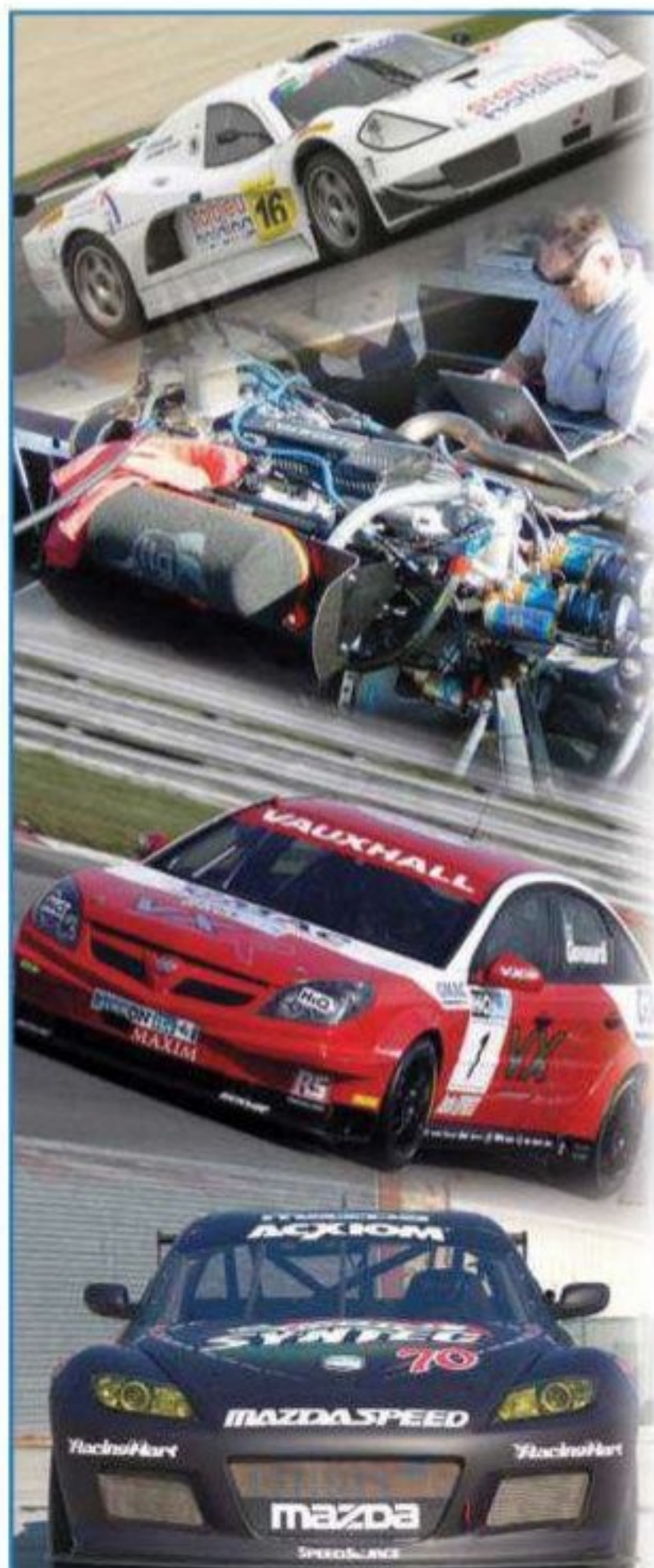
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Jetblack

Announced during October 2011, when the eyes of much of the sporting world were on New Zealand watching the Rugby World Cup, Jetblack is the most recent contender to enter the race to the world land speed record. The first such project to emerge from New Zealand, Jetblack is aiming to attempt the record in 2016 and ultimately go on to break 1000mph, and has put together a partnership of national and international minds and companies to set about that aim. The design team includes Wing Commander Frank Dyer (lead engineer) and Glynne Bowsher (wheel design), formerly chief mechanical engineer on Thrust SSC.

Project founder and director,

Richard Nowland, was originally intent on breaking the New Zealand and Australian land speed records, after successfully bidding for a pair of ex-RAF Rolls Royce Avon 206 turbojet engines in an online auction in 2007. But since then his sights have been raised and now his brainchild, Jetblack, is to be powered by a turbofan engine and two 'throttle-able' hybrid rocket motors, the latter being manufactured by the Space Propulsion Group in California using similar technology to the engines used by Virgin Galactic's passenger spacecraft.

Naturally, Jetblack has to accommodate intakes for its jet engine, but the team's aerodynamicist, Richard Roake, does not see this as a cause for

TECH SPEC

Jetblack (www.jetblack.co.nz)

Length: 12.9m (42ft 4in)

Weight: est. 3500kg (7700lb) dry

Chassis: carbon composite monocoque

Engine: Turbofan plus two hybrid rocket motors

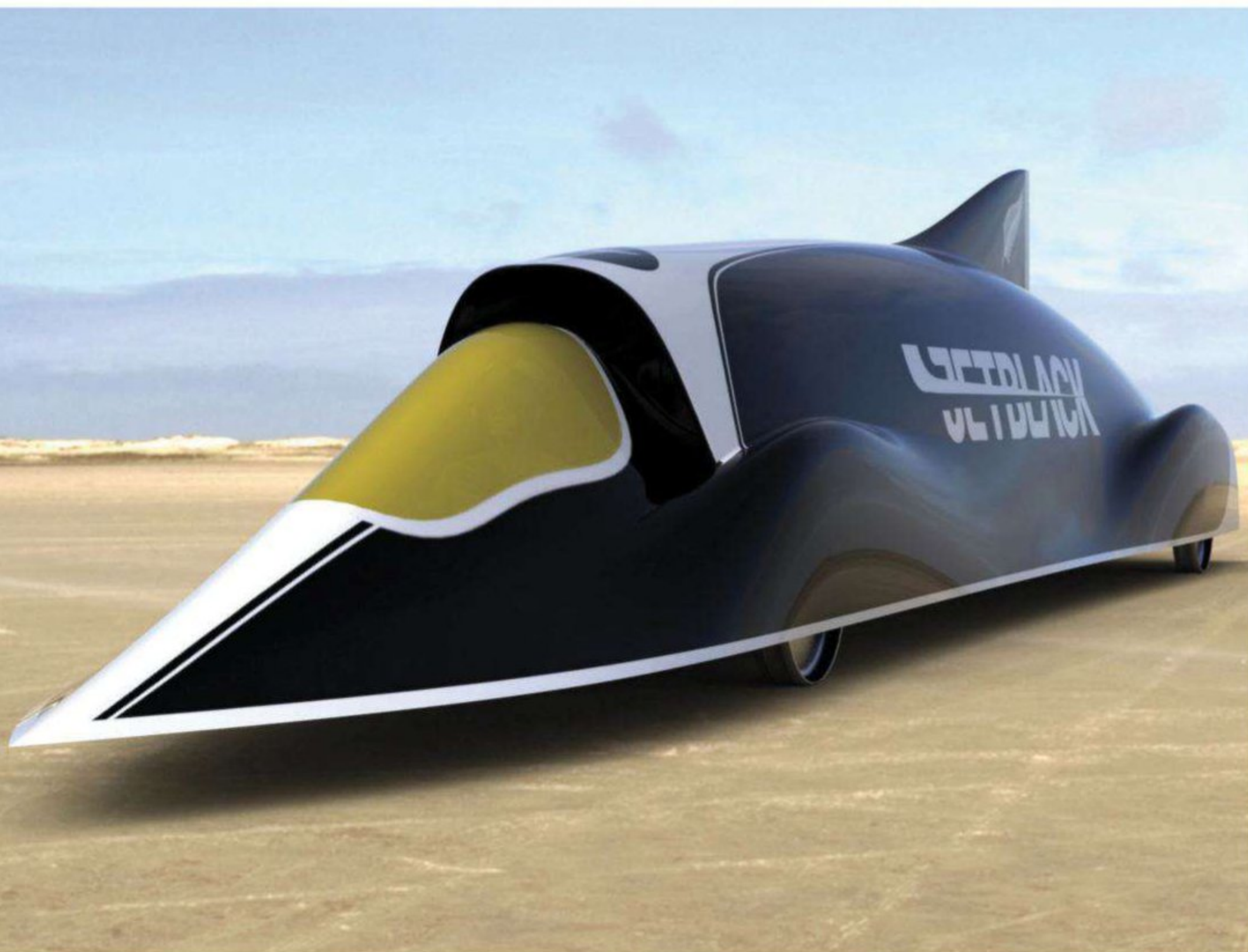
Thrust: Turbofan up to 20,000lb (89kN); rockets - two x 20,000lb (178kN)

Wheels: 850mm diameter forged aluminium

Brakes: not specified

no problems up to our design speed, but the mass flow inside the intake did not match our expectations so more work is required here.'

Not only is Jetblack a completely different shape, it will have the only all-composite chassis among the current crop of land speed record contenders, designed by Dr Mark Battley of Applied Engineering Research Ltd. Thanks to its world class boat building prowess, as showcased in the America's Cup, New Zealand is a centre of excellence in composite technology, and this expertise will be tested to the full as the project steers clear of the usual and perhaps more conservative steel frame chassis found in most land speed record vehicles. 



Aussie Invader 5R

The team principal at team Aussie Invader is Rosco McGlashan OAM, the current Australian land speed record holder at 498.2mph (801.8km/h) set in 1994 in Aussie Invader 2. A week later he had been running at around 580mph when the vehicle broke through the salt surface and was written off.

Aussie Invader 5R (AI5R) has been 11 years in planning and design, and construction began in 2009. As of November 2011 it was said to be approximately 40 per cent complete. Subject to the all-important finance being raised, it is hoped to start running the car by late 2012 or early 2013. The technical team is led by chief designer, Dr Ian Sutherland, and includes John 'Ackers' Ackroyd of Project Thrust fame.

The vehicle's 40ft (12.3m) chassis is based on a 36in (914mm) diameter steel tube with transverse bulkheads along its length. The nose section, v-shaped underbelly and top chassis section are in composite, the rollcage is 4130 tubular steel.

The 'R' in AI 5R stands for

'rocket', and originally it was planned to use four small (15,500lb thrust) hypergolic (self-starting) motors that would have effectively allowed throttle control by virtue of being able to start and stop the motors as required. However, because of potential problems with supply, plus the cost and handling difficulty of the proposed oxidiser, HTP, or high test peroxide (H2O2) the team opted instead for liquid oxygen (LOX). This resulted in the switch to a single motor, similar to that formerly propelling Atlas rockets used by NASA and as inter-continental ballistic missiles.

'A rocket-only car to us is the only way to go,' says McGlashan. 'High-mounted intakes create lift, as Craig Breedlove discovered in 1966.' Fellow AI team member, Brett Boughton, agrees: 'Rockets have a massive advantage in terms of drag reduction. Because the Invader doesn't need an air intake it punches a much smaller hole in the air and therefore requires less thrust to attain the same target speed than jet-powered vehicles.'

TECH SPEC

Aussie Invader 5R
(www.aussieinvader.com)

Length: 52ft (15.85m)

Weight: 9163kg (20,159lb) fuelled, 6363kg (14,000lb) empty

Chassis: steel tube monocoque with transverse bulkheads; composite nose, under belly and top section; 4130 steel rollcage

Engine: LOX/bio-kerosene pressure fed liquid bi-propellant rocket

Thrust: 275kN (62,000lb)

Wheels: four 900mm x 200mm solid forged aluminium alloy 2014T6

Braking: air brakes; parachutes; electro-magnetic wheel brakes

continued burning, and it goes through a progressive shut down sequence to prevent excessive deceleration.

The propellants are fed to the engine using a high-pressure, onboard helium supply, rather than complex pumps and ancillaries. Although this adds extra weight, it is not seen as an issue, but rather a benefit because maximum acceleration has been set at 3.2g in order that wheel rotation can keep up.

To slow down, AI 5R uses a combination of natural aerodynamic drag, rear air brakes that are deployed at approximately 1100km/h (684mph), parachutes deployed at 480km/h (300mph) and 320km/h (200mph), and electro-magnetic brakes, which are actuated from about 290km/h (180mph). Suspension features a compressed rubber unit for the nose bogey that carries the front wheels and permits 25mm (1in) of suspension travel and +/- five degrees of steer. The solid rear axle is 125mm (4.9in) in diameter and has no suspension travel.



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Silver Bullet RV1

The Bullet Project's principals, Mark Stephenson and Paul Noone, started their project in 2009, and refer to themselves as 'new kids on the block'. However, an ambitious timeframe has been set, with Silver Bullet JV1, a jet-powered variant, hopefully testing wheel, driver capsule and 'aeroshell' concepts in late 2012. 'This will give us actual data at speeds of 600+mph to compare with computer generated analysis,' explained Noone. Such speeds would also collect an Australian land speed record along the way.

The team then hope to take to the salt in 2014. 'It's a tight schedule we know,' continued Noone, 'but this is what we need to keep in line with the seasoned professionals. Currently, we are on target, with everything in place ready to start working. Now, like all the other teams, we need to find funding and are, at present, securing professional assistance. We have plans for a full-size model of RV1 to be

constructed, followed by an Australia-wide tour to raise the project's public profile.'

RV1 is one of the smaller designs at just 30ft (9.14m) long, with a composite monocoque construction with detachable panels for internal access. 'Our thinking is that a moulded chassis and 'aeroshell' eliminates joints, and that every joint is a potential weak point,' says Noone.

ENGINE

Like the other Australian entry, RV1 will use rocket-only propulsion, for reasons Noone explains: 'Inlet ducts [for a jet engine] present a big challenge that is eliminated with a pure rocket car. Such ducts tend to de-stabilise a car by moving the centre of pressure forwards, and increase drag by creating an abrupt increase in cross section that generates additional shock waves. By contrast, because liquid propellant rocket motors are so light, it's easier to juggle other components to optimally place the c of g.'

TECH SPEC

Silver Bullet RV1

(www.bulletproject.com)

Length: 30ft (9.14m)

Weight: 6000kg (13,200lb) dry

Chassis: composite monocoque

Engine: six AUSROC 2.5 LOX / kerosene throttle-able; pressure-fed liquid bi-propellant rockets

Thrust: 47,000lb (210kN)

Wheels: fixed hubs with rotating 'tyres' on nitrogen-fed 'air' bearings; integral suspension

Brakes: ballutes; possible air brakes; wheel brakes

Details are sparse at this early stage but one area the team does go into is an interesting wheel design, intended to reduce rotational inertia using a fixed hub with a rotating rim. The hub is said to incorporate an internal suspension system comprising rubber blocks and adjustable friction dampers. The wheel rim will then rotate around the hub and be supported on air bearings that will actually be fed with nitrogen from an onboard supply.

Braking from high speed will be by 'IADs' or inflatable aerodynamic decelerators, sometimes known as ballutes, while low-speed braking will be via friction from within the wheel design. The team is also investigating a new design of air brake for medium speeds.

Another possibly unique concept among the current batch of designs is a detachable driver safety capsule. The aim would be for the capsule to self-level and land softly in the event of an unforeseen or unpreventable incident. 

Six AUSROC liquid bi-propellant oxygen / kerosene 'throttle-able' rocket motors are being used, fed by pressurised nitrogen. The Royal Melbourne Institute of Technology is currently designing these for the Australian Space Research Institute, so this is an all-Australian engine project. The aim is to exceed 1000mph.



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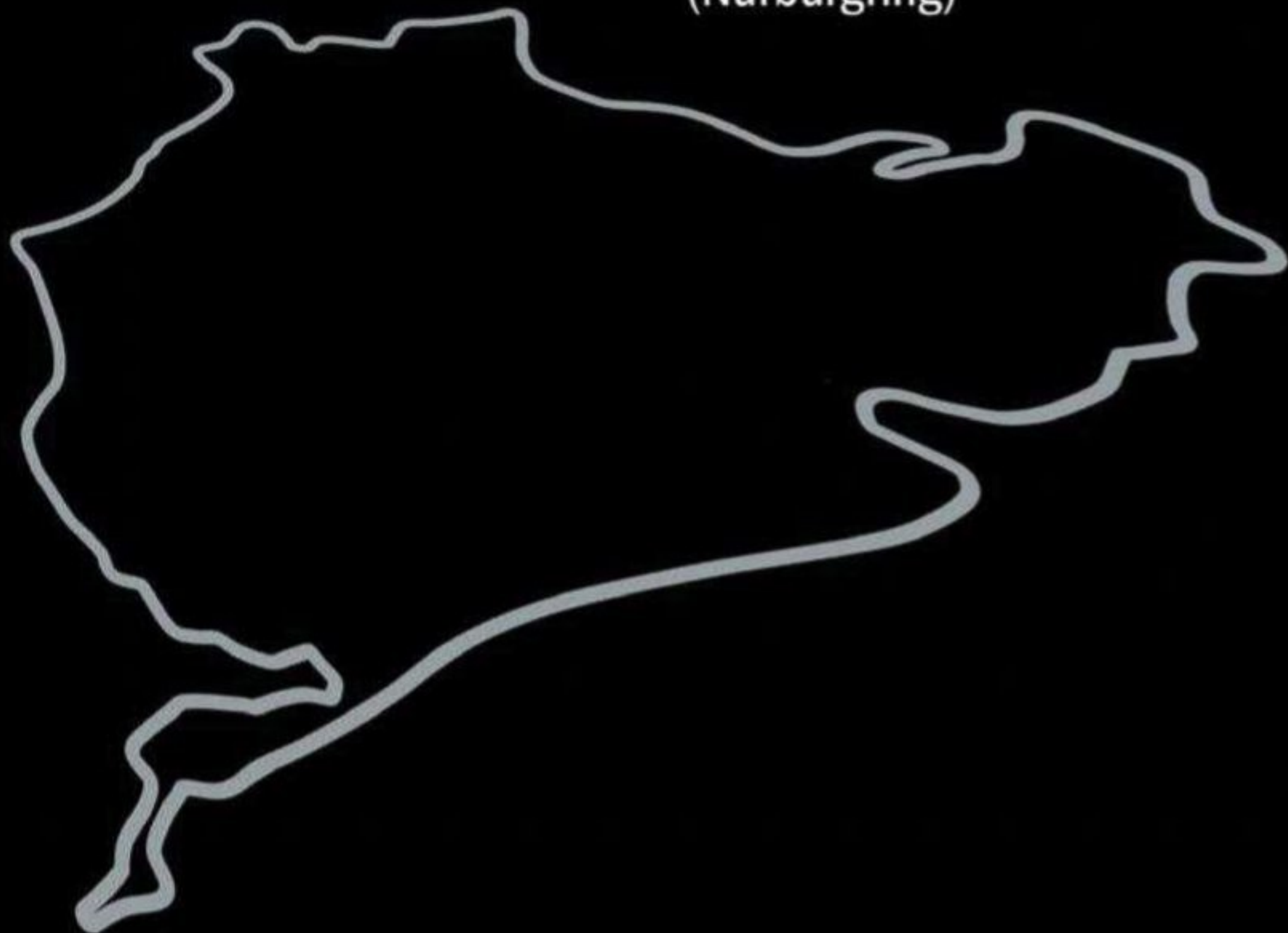
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Sonic Wind

The Sonic Wind project, under team principal and possible driver, Waldo Stakes, started about five years ago, with four designs using different rocket engine and fuel combinations. But in late 2010 the design evolved into what we see now, thanks to the availability of certain hardware, including its modified Thiokol XLR-99 rocket engine. However, the project is clearly an evolving one, as Stakes' comment, 'The design is always in a state of flux due to the availability of better hardware,' proves. The stated goal is 1000mph and beyond.

Sonic Wind is said to be 60-70 per cent complete, and engine tests are planned for Spring 2012. Then, funds permitting, the team hopes to make its record attempt in the summer and autumn of 2013.

Sonic Wind is certainly one of the slimmer, lighter designs, and is said to weigh in at just 3100kg (6800lb) fuelled up. The steel frame chassis and most

of the major parts have been manufactured at Stakes' 'Rocket Ranch' in southern California, mostly by himself and Accurate Arc Inc, California. But many parts have been obtained from surplus NASA and US military supplies, including of course the motor, which is of the type originally used in the North American X-15 aircraft. Other parts come from the Apollo service module, the Saturn 5 rocket, Redstone, Honest John and Corporal missiles and the F-104 Starfighter jet.

Rocket engineer, Daniel Moser of Compositex Inc, Utah, is carrying out the engine design and modification work. The core engine is being mated to a new composite combustion chamber and nozzle designed by Moser, which Stakes says, 'will make the engine perfectly suited to the altitudes of the venues at which we will be running. It will allow us to run the engine at lower pressures, making it more reliable and safer. It will also run cooler on the methanol

TECH SPEC

Sonic Wind

(www.landspeedrecordrocketcar.com)

Length: 47ft (14.3m)

Weight: 6800lb (3090kg) fuelled, 3000lb (1364kg) dry

Chassis: fabricated steel

Engine: Thiokol XLR-99 liquid bi-propellant methanol / kerosene throttle-able rocket

Thrust: 26,000-34,000lb (116-151kN)

Wheels: titanium ring running on hardened steel hubs

Brakes: air brakes; parachutes; surface drag brake

/ LOX (liquid oxygen) mix than it's original aqueous ammonia / LOX mix. Thrust will be slightly reduced compared to the original motor but it will have a two-stage throttling capability with about 26,000lb of thrust for initial lighting and low throttle, but then it can be wicked up in the

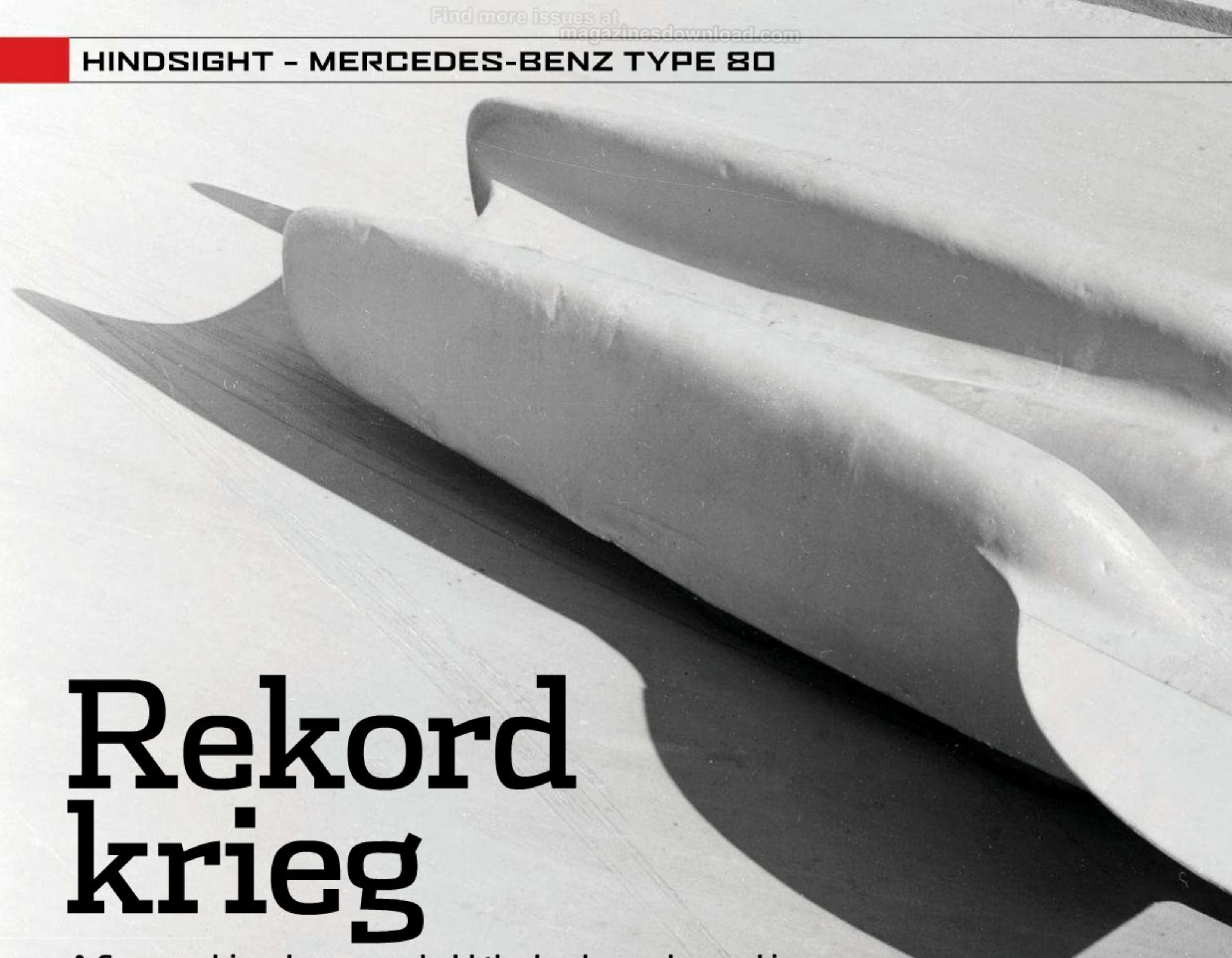
transonic speed range to over 34,000lb of thrust for top speed.'

Stakes is another looking at reducing the rotational inertia of the wheels by employing an outer rim rotating on a large diameter fixed hub, with titanium rings running around hardened steel hubs, lubricated with water.

High-speed braking will be done by air brakes and by deploying reefed supersonic ring slot parachutes, while low-speed braking is via a surface friction drag brake. The vehicle will be brought to a complete stop by pneumatically collapsing the rear suspension so the rear of the car drags on the surface.

The team has reduced the frontal area by half, to just over eight square feet. The vehicle now has a constant slope top side and a better plan form that directs airflow over the body better than before. The team predicts that Sonic Wind LSRV will be even more stable on all axis and generate even more negative lift.





Rekordkrieg

A German driver has never held the land speed record in a German car, but 75 years ago it very nearly happened

BY CHARLES ARMSTRONG-WILSON

In 1930's Germany, a great deal of engineering was done in secret, mainly due to the Treaty of Versailles that severely restricted the country's re-armament. But, in 1945, when Allied forces entered the Daimler-Benz facility in Stuttgart, they discovered one project that came as a complete surprise. With six wheels and a 44.5-litre engine, the so-called Type 80 was a car designed to take the outright World Land Speed Record.

What the troops found was an incomplete car that had never run and, like everything they encountered, they documented it in great detail, in the process learning that it had a number of remarkable features designed to

help it achieve its target.

During the 1930s, both the Mercedes-Benz and Auto Union racing teams had chased speed records, but only ever class honours, using streamliners derived from their grand prix cars. Although German teams dominated grand prix racing during the decade, the Land Speed Record was held by a succession of English drivers. Between them, Malcolm Campbell, Henry Segrave, Parry Thomas, George Eyston and John Cobb had formed a small club that would hold the record almost exclusively for two decades.

This obviously rankled with the country's star driver, Hans Stuck, who had enjoyed a glittering career with Austro-

Daimler, Daimler-Benz and Auto Union. Stuck decided that, if his achievements as a driver were going to be complete, he needed to hold the ultimate prize - the World Land Speed Record.

At the time, land speed record (LSR) cars were powered by aircraft engines, because their huge capacity allowed them to deliver the necessary power. In 1935, Malcolm Campbell's Bluebird, for example, had pushed the record to over 300mph using a Rolls Royce V12. Stuck realised that to have a serious crack at the record, he would also need an aero engine.

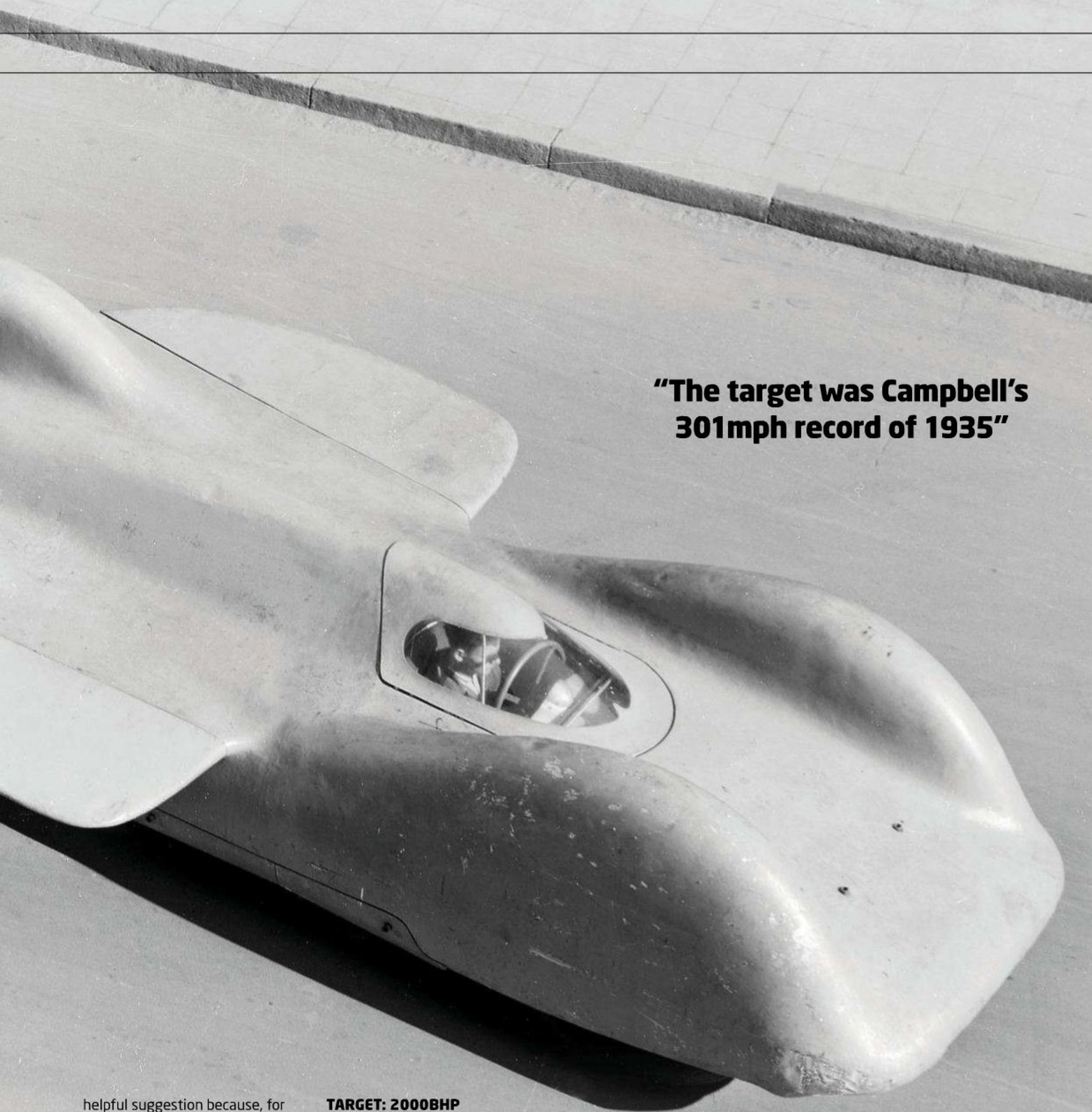
Much as in the UK, aero engine projects were funded and controlled by the government, for military purposes. Nobody could

stroll along to a manufacturer and just buy one. Fortunately, Stuck was well connected and able to call on his old chum, Ernst Udet, the Third Reich's director of aircraft procurement.

TOP SECRET

Negotiations yielded access to the still top secret Daimler Benz DB600 series V12s, already putting out 1000bhp each, and with plenty of development potential. This gave power to Stuck's elbow, but he then needed a designer. The obvious choice was Ferdinand Porsche, the man responsible for the Auto Unions the driver was racing.

Porsche was very enthusiastic and even offered to do the job for free if necessary - a



**“The target was Campbell’s
301mph record of 1935”**

helpful suggestion because, for all his influence, Stuck had no finance for the project. He was, however, resourceful and did the unthinkable, by pitching the project, complete with Porsche as designer, to Daimler Benz (DB).

Fortunately, despite being the opposition, Porsche and Stuck were highly regarded at the rival manufacturer and, after a little soul searching, they agreed to build the car under the title Type 80. Apart from anything, they were worried that Stuck would take the promise of DB’s aero engines and have the car built by someone else.

TARGET: 2000BHP

The target was Campbell’s 301mph record of 1935 and Porsche’s calculations showed he needed more than 2000bhp to break it. That would mean two engines, a solution that both Eyston’s Thunderbolt and Cobb’s Railton Special would employ over the next couple of years, each utilising a pair of Rolls Royce V12s. However, knowing the engines would be used at ground level, Daimler Benz was able to promise a much higher output, enough to break the record with just one engine.

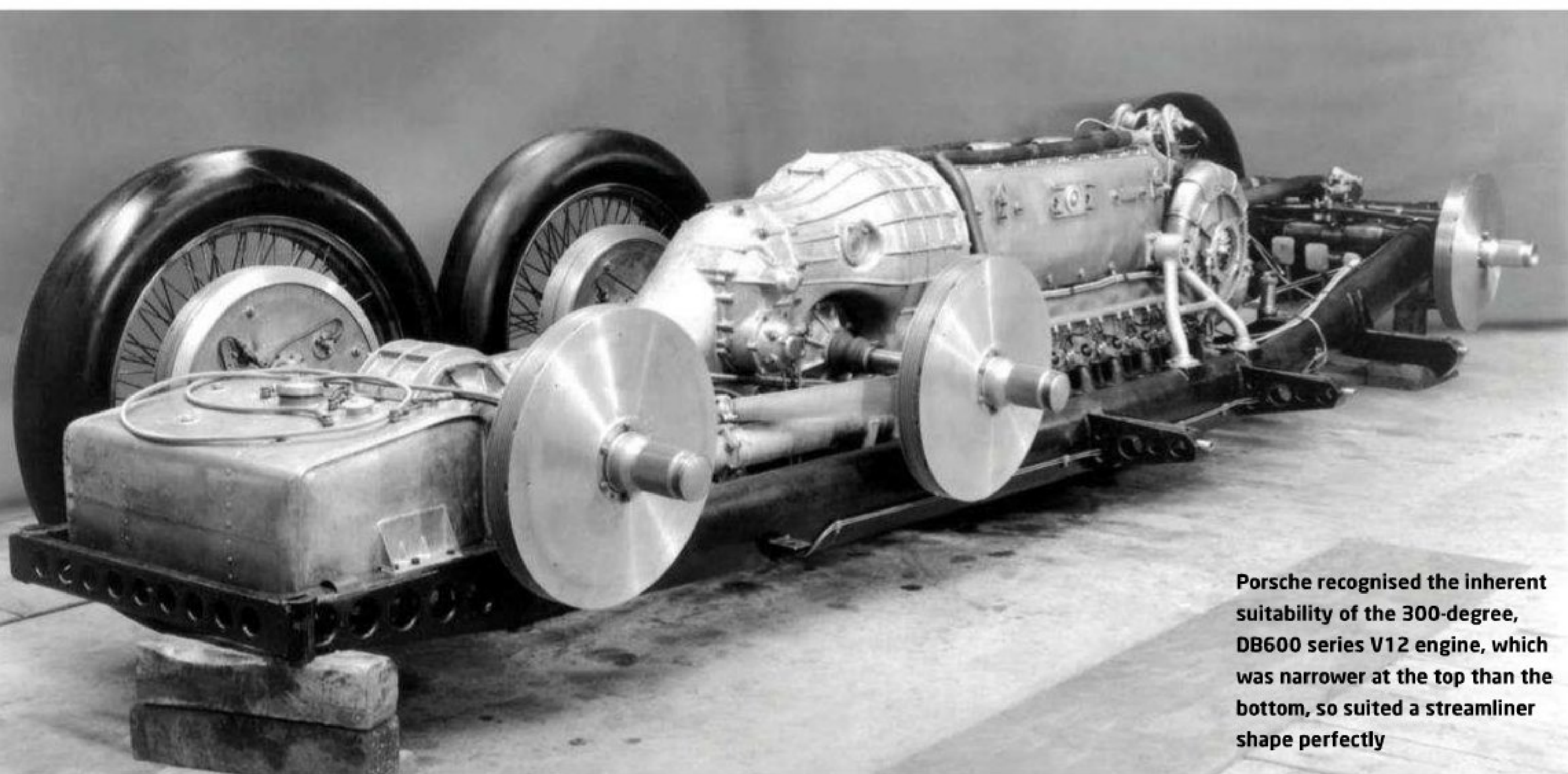
This pleased Porsche, who

clearly recognised the greatest challenge to pushing the record higher was aerodynamic drag. The standard approach was to assemble as much power as could be squeezed into a chassis and wrap it in a slippery shape. But Porsche looked at the problem slightly differently. At these speeds the limiting factor is not just the amount of power, but the ability to put it down as you push

against an unyielding wall of air.

Porsche stayed with the mid-engined concept he was using successfully on the Auto Union grand prix cars, allowing him to put the driver low down at the front of the car.

Strictly speaking, the 600 series engine was a 300-degree V12, although most would regard it as an inverted 60-degree v. It was used in the Messerschmitt



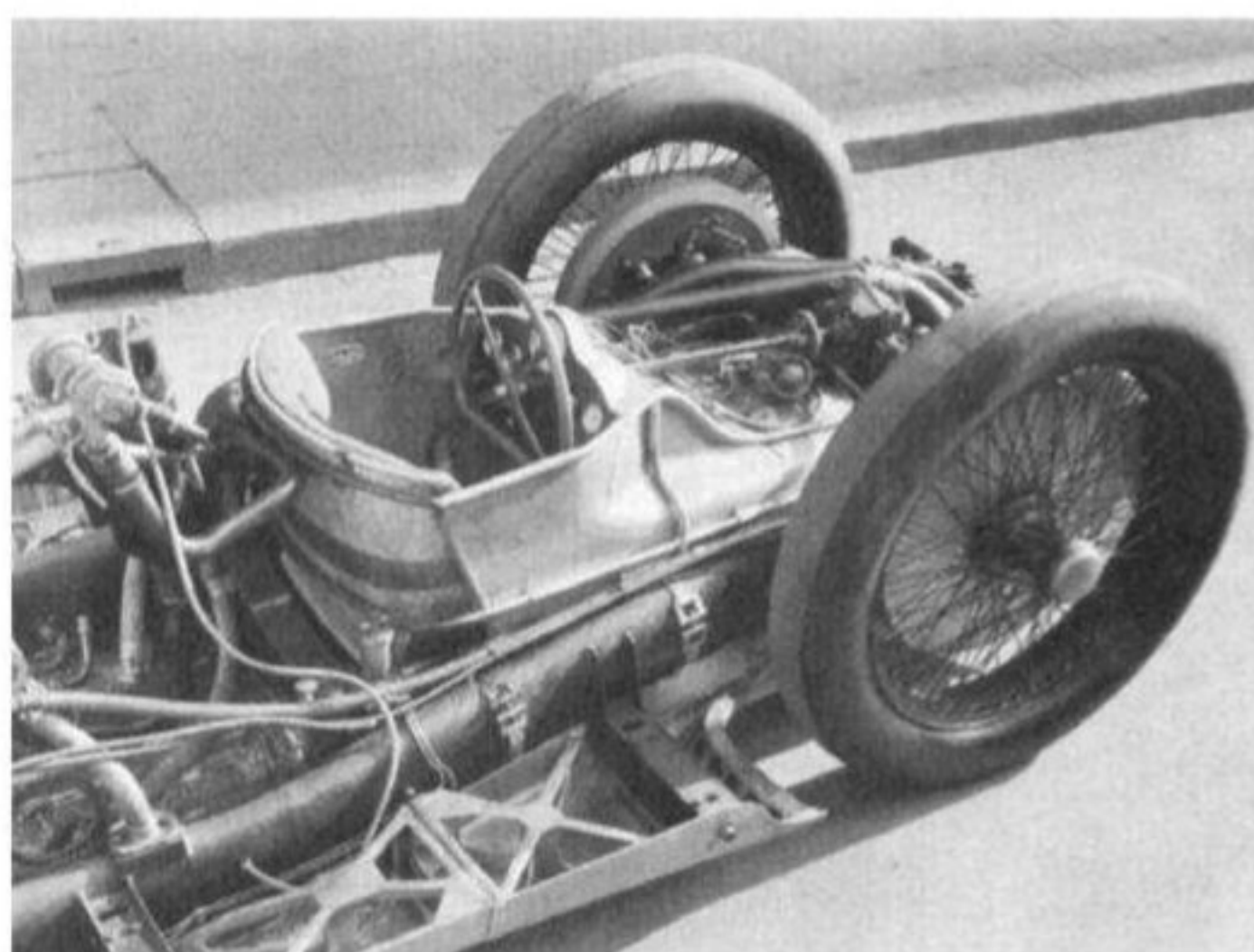
Porsche recognised the inherent suitability of the 300-degree, DB600 series V12 engine, which was narrower at the top than the bottom, so suited a streamliner shape perfectly

Bf110 twin-engined heavy fighter and was designed from the outset to be able to fly inverted. So the crank is at the top and the cylinders project beneath it. This put the narrowest part of the engine at the top where it fitted neatly behind the profile of the driver, while the wider part with the cylinder heads and manifolds was buried out of the airstream between the chassis rails.

This allowed the car to have a low upper deck, only broken by fairings for the driver, engine and wheels. Add to this a remarkably narrow track of just 4ft 3in (1295mm), which the Allied report noted was a full 6in (150mm) narrower than the company's 1939 grand prix car. Together with the use of just one engine, these measures significantly reduced the overall frontal area, compared to the equivalent English cars, to around 18-20sq.ft. Its drag coefficient was claimed to be just 0.18.

AERODYNAMICS

To execute the all-important aerodynamics, Porsche shrewdly brought in specialist, Josef Mikl. One danger was the combination of the front-mounted cockpit canopy and the large fairings forced by the 32in wheels, which raised the possibility of the centre of pressure being too far forward, particularly with



Using his experience with the all-conquering Auto Union grand prix cars, Porsche sat the driver up front, minimising frontal area as far as possible

the largest single mass in the car - the engine - being toward the rear. Porsche's solution was to extend the rear wheel fairings a long way behind the rear axles, turning them into stabilising fins. This created a very long car,

of aerofoil-profiled wings at an angle of incidence of -5 degrees.

This was not a first, as Fritz von Opel's rocket car, RAK 2, had used wings to aid stability a decade earlier. However, as it was thrust driven, traction was

"The final masterstroke... was the car's 'anti-spin control'"

at 26ft 8in, almost double the length of its 14ft wheelbase.

Not content with reducing the demand on the car's traction, Mikl went one step further, incorporating his own patented devices. Either side of the car, amidships, he mounted a pair

not an issue. On the Type 80, at more than 300mph, they would certainly have helped cancel lift, if not make a net contribution to the load on the driven wheels.

The next step was to feed the power through twin rear axles, doubling the contact patch of the

driven wheels. Power from the engine was transmitted via an hydraulic torque convertor to a single-speed final drive. As the drag on the car at slower speeds would be very small compared with the power of the engine, lower gears were redundant.

SKID CONTROL

The final masterstroke, which shows most clearly how Porsche was thinking, was the car's 'anti-spin control'. Two flexible drives, like speedometer cables, were taken from the wheels, one from the front and one from the rear. They were then fed into either end of a miniature mechanical differential unit, much like a final drive. Because they turned in opposite directions, under normal circumstances their motions cancelled each other out. However, if the rear wheels broke traction and started to turn faster than the fronts, the unit's outer cage started to turn. This motion acted on the engine's injector unit, rolling off the power. It was a simple mechanical manifestation of a system that is now commonplace in most road and some racecars, thanks to digital management systems. However, it was ground breaking in 1935 and could have been invaluable to help accelerate a very powerful car within a limited distance on a potentially low-grip surface.



A dark-colored F-35 fighter jet is shown in a steep climb against a clear blue sky with some light clouds. The aircraft's canards and wings are visible, and a small amount of white smoke is trailing from the rear.

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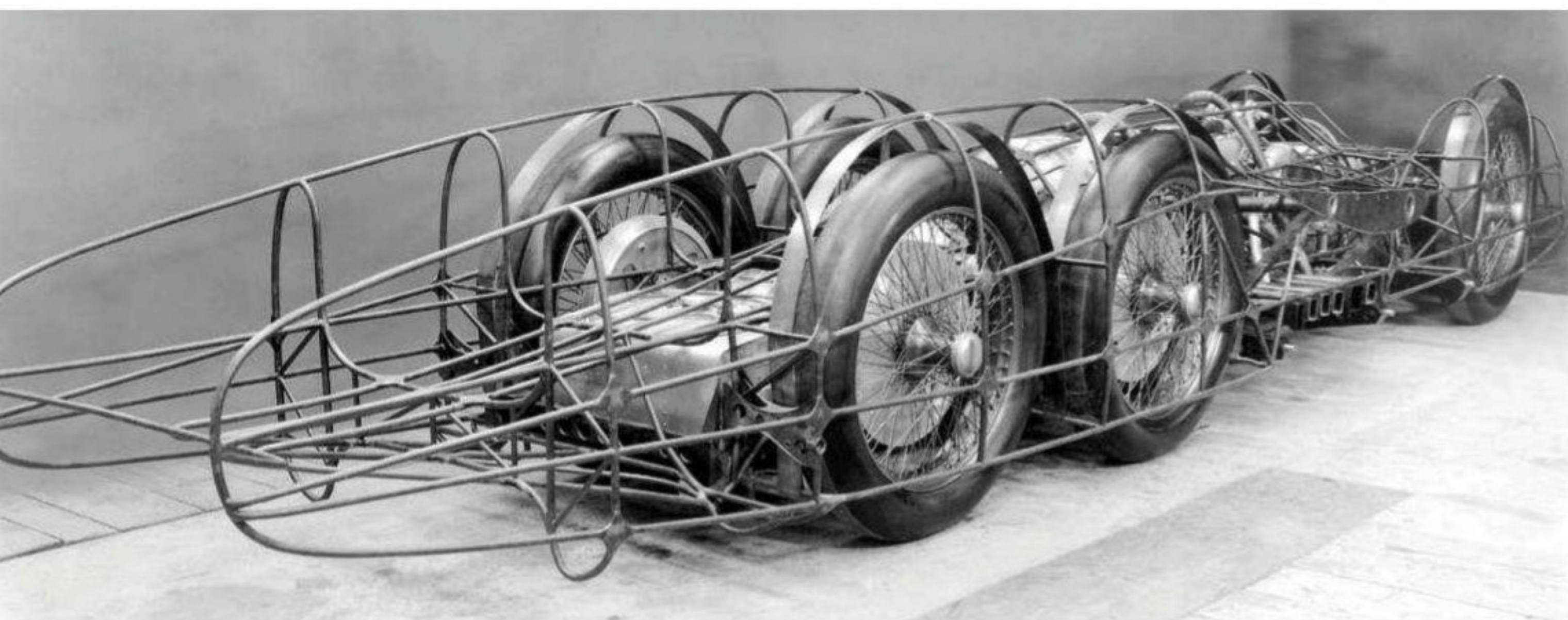
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HINDSIGHT - MERCEDES-BENZ TYPE 80



Top: wire frame clearly shows how much longer the body was than the chassis it covered, the idea being to use the huge tail fins to stabilise the car at speed. **Above:** car now resides in the Mercedes museum in Stuttgart

TECH SPEC

Mercedes-Benz Type 80

Engine DB603

Cylinders 12

Configuration 300-degree v

Capacity 44,500cc

Compression ratio 8.5:1,
turbocharged

Induction mechanical fuel injection

Boost 15lb/sq.in

Fuel alcohol

Power 2830bhp at 3000rpm

Transmission single-speed drive
with hydraulic torque convertorTop speed (claimed) 750km/h
(466mph)

Dimensions

Width - 1753mm (5ft 9in)

Length - 8128mm (26ft 8in)

Height - 1245mm (4ft 1in)

Wheelbase - 4267mm (14ft)

Track - 1295mm (4ft 3in)

Weight 2896kg (6385lb)

By the end of the war, the car's DB603 engine had been removed and returned and the car was parked up in a corner where the arriving Allied troops discovered it.

Could it have been the fastest car on the planet? When recording what they found, the Allies were quoted a top speed of 750km/h (466mph), considerably more than the record at the time. However, this was only an estimate of the top speed they expected the car to achieve, and it is notable that this figure was not exceeded by a wheel-driven car until 2001 when Don Vesco's Turbinator managed 470mph for the flying mile at Bonneville.

Also, the 3000bhp hoped for from the DB600 engine never materialised. An experimental DB603 was quoted as delivering 2830bhp, and this is the figure that appeared in the Allied report. Perhaps it could have been optimised for ground-level operation and exceeded 3000bhp, but more pressing matters during the 1940s prevented that from happening.

Come 1947, John Cobb had taken his Railton Special back to Bonneville, with backing from Mobil, and pushed the record to 394mph. This may have been the final nail in the Type 80's coffin as the car was never resurrected. It now resides in the Mercedes Museum in Stuttgart, having never turned a wheel under its own power, but remains a tantalising vision of what might have been.

**"An
experimental
DB603 was
quoted as
delivering
2830bhp"**

SYSTEM PORSCHE

Mechanically, the car borrowed heavily from Porsche's design practice at Auto Union. Its chassis was a large diameter, twin-tube structure and the rear suspension used simple short swing axles located fore and aft by radius arms.

But even as the car was being designed, the English drivers were moving events forward. In 1937, George Eyston's Thunderbolt raised the record from Campbell's 301mph to 312mph, and the following year to 345mph. That moved the goal posts significantly, although the

Daimler-Benz engine builders promised they could come up with more power to compensate.

By the time the car was complete in 1939, John Cobb, driving the Railton Special, had pushed the record to 370mph. But Porsche was promised as much as 3000bhp from the fast developing engine, so remained optimistic that the outright record was still within their grasp. The car was due to run on the Dessau Autobahn in January 1940, during the RekordWoche (Record Week). But by now, world events were dominating and the event was postponed.

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Pocket rocket

One tenth scale model of the JCB Dieselmax record holder targets 200mph

An accident in the desert on a motorbike gave Ford model maker, Nic Case, something of a wake-up call. The American was taking part in a desert race, and while he was uninjured in the shunt, a sense of his own mortality came over him.

Case stopped riding his bike, and instead turned to racing radio-controlled cars. That new-found passion evolved into an attempt on the radio-controlled speed record, which he now holds at 161.76mph, and Case plans to crack the 200mph record with his new creation, the SR11, an

BY ANDREW COTTON

extreme evolution of the original record holder, based on the JCB diesel speed record machine.

'The original V1 body was inspired by the JCB Dieselmax,' says Case. 'The general curves and basic layout was gleaned from them, and that holds the record. For V2, we received some key CFD support from CD Adapco in 2009, and ended up with a drag coefficient improvement to .201! That body worked well until we started going to 175mph plus, and then a blow-over condition reared its ugly head in September 2010.'

BODYLINE

Flying cars are a phenomenon that has been experienced by Le Mans Prototypes, but the RC car clearly had a different problem. A frame-by-frame analysis showed that the nose of the car was actually deforming at speed, and

that the carbon fibre and foam reinforcements were not enough.

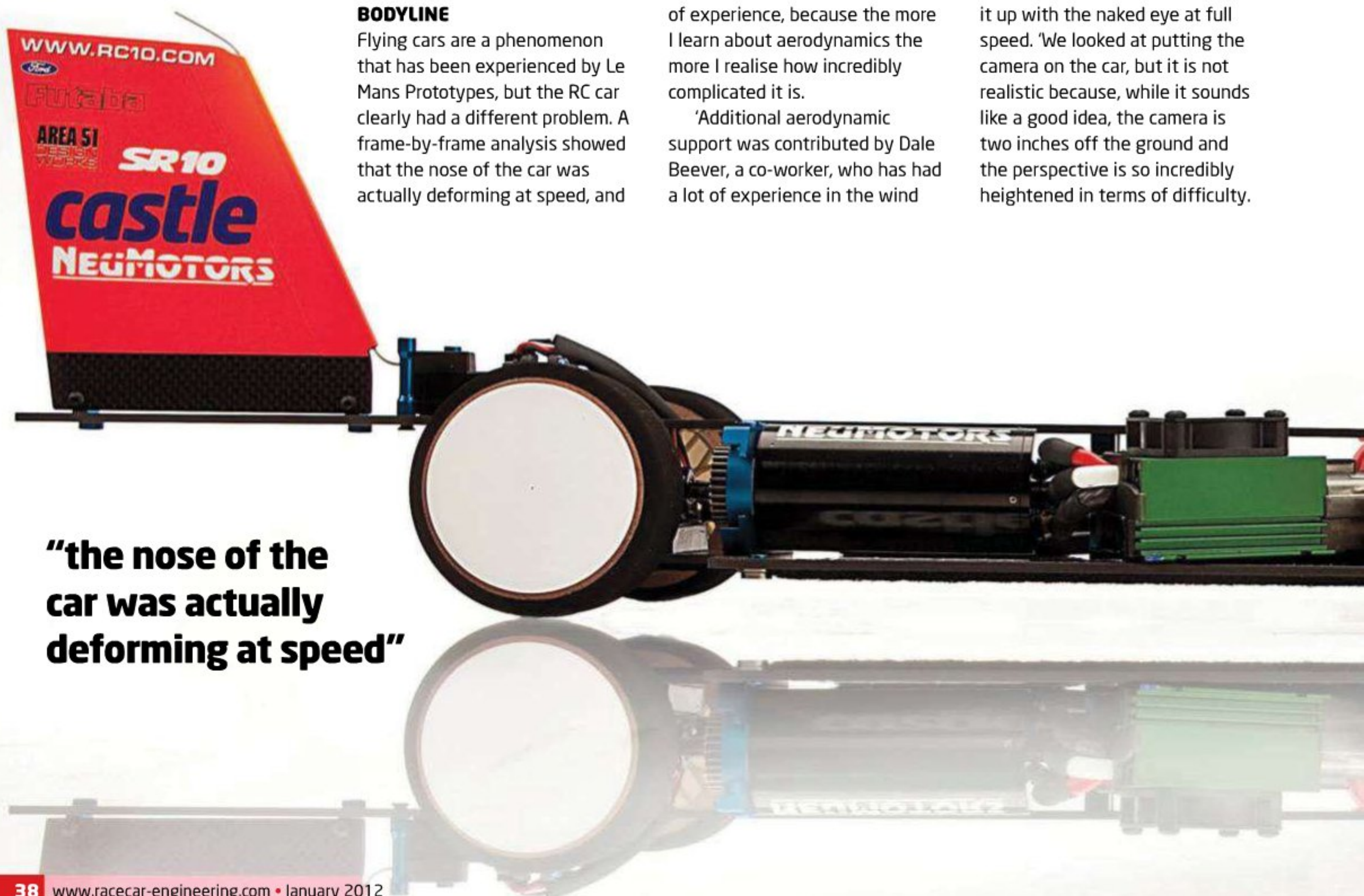
Version four of the body features a complete carbon fibre body structure with an adjustable splitter and wheel exhaust vents for the front wheels. Adding weight to the nose helped too, and the overall weight of the car increased to 13lb. That has put extra pressure on the driveline, but the team is confident that it can set a new record with the car.

'The big unknowns right now are the aerodynamics,' explains Case. 'Even though the car has been in CFD, it is not real-world conditions, with weight transfer and body deformation. The CFD didn't really pick up the potential problems, or maybe it is my lack of experience, because the more I learn about aerodynamics the more I realise how incredibly complicated it is.'

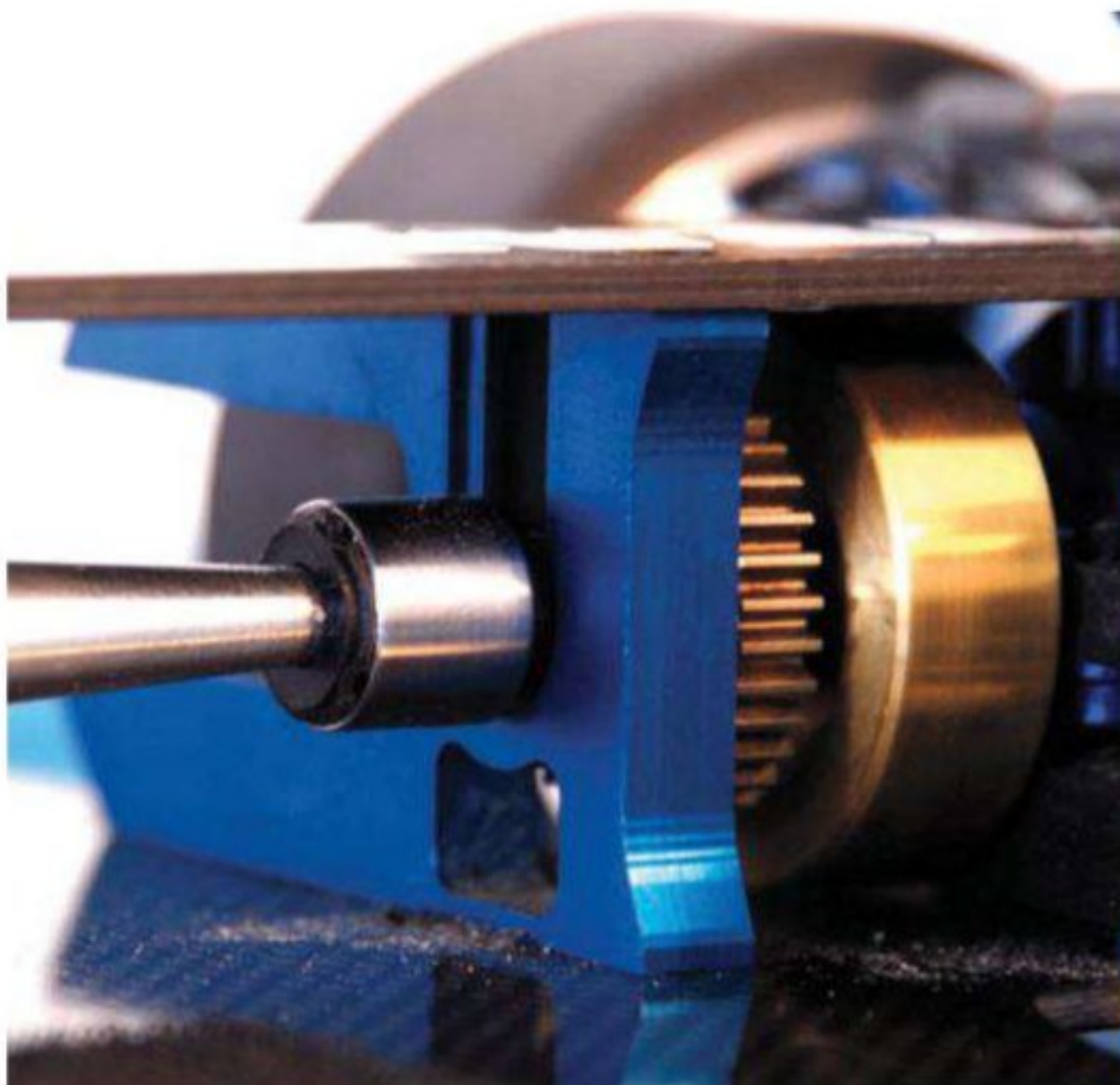
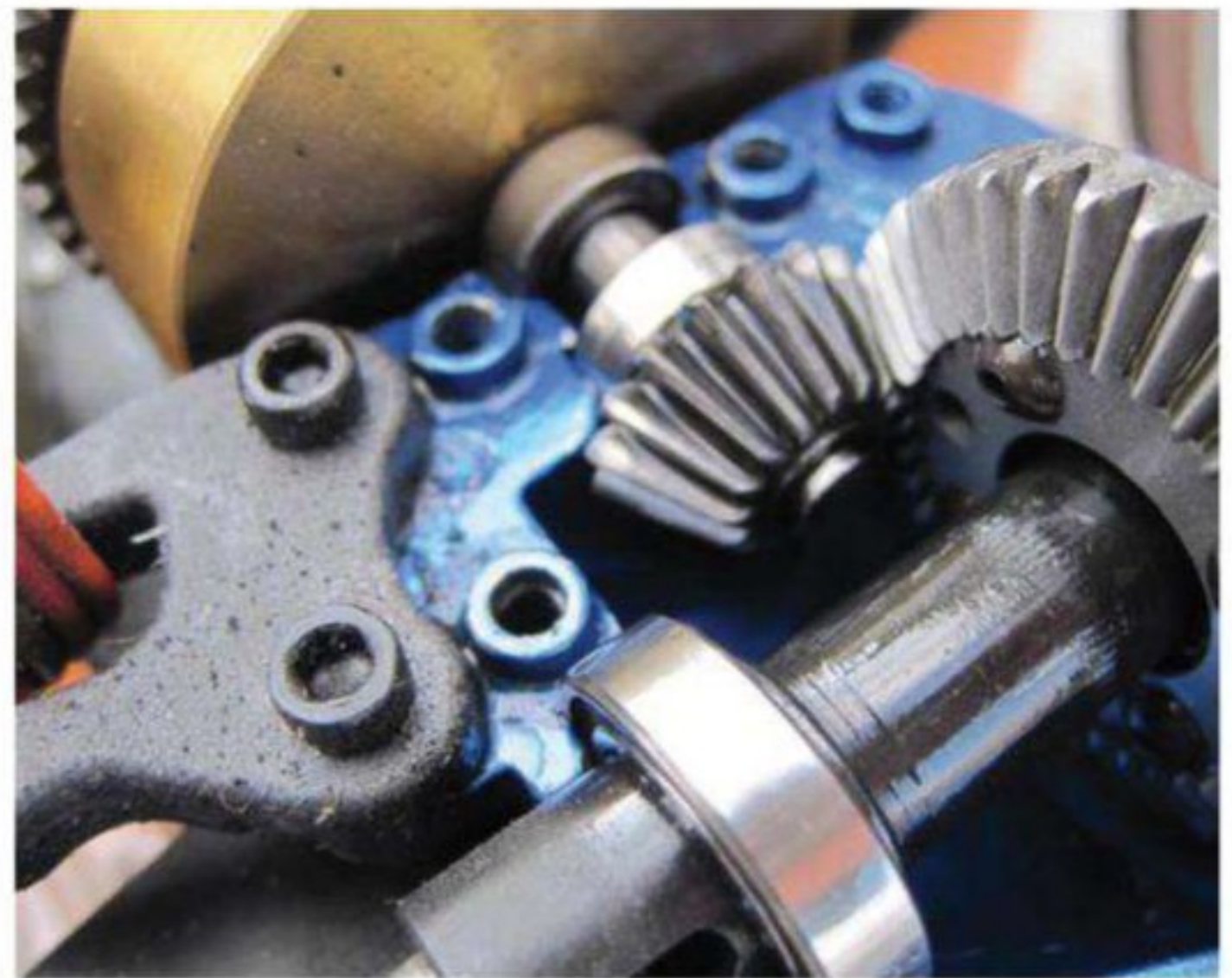
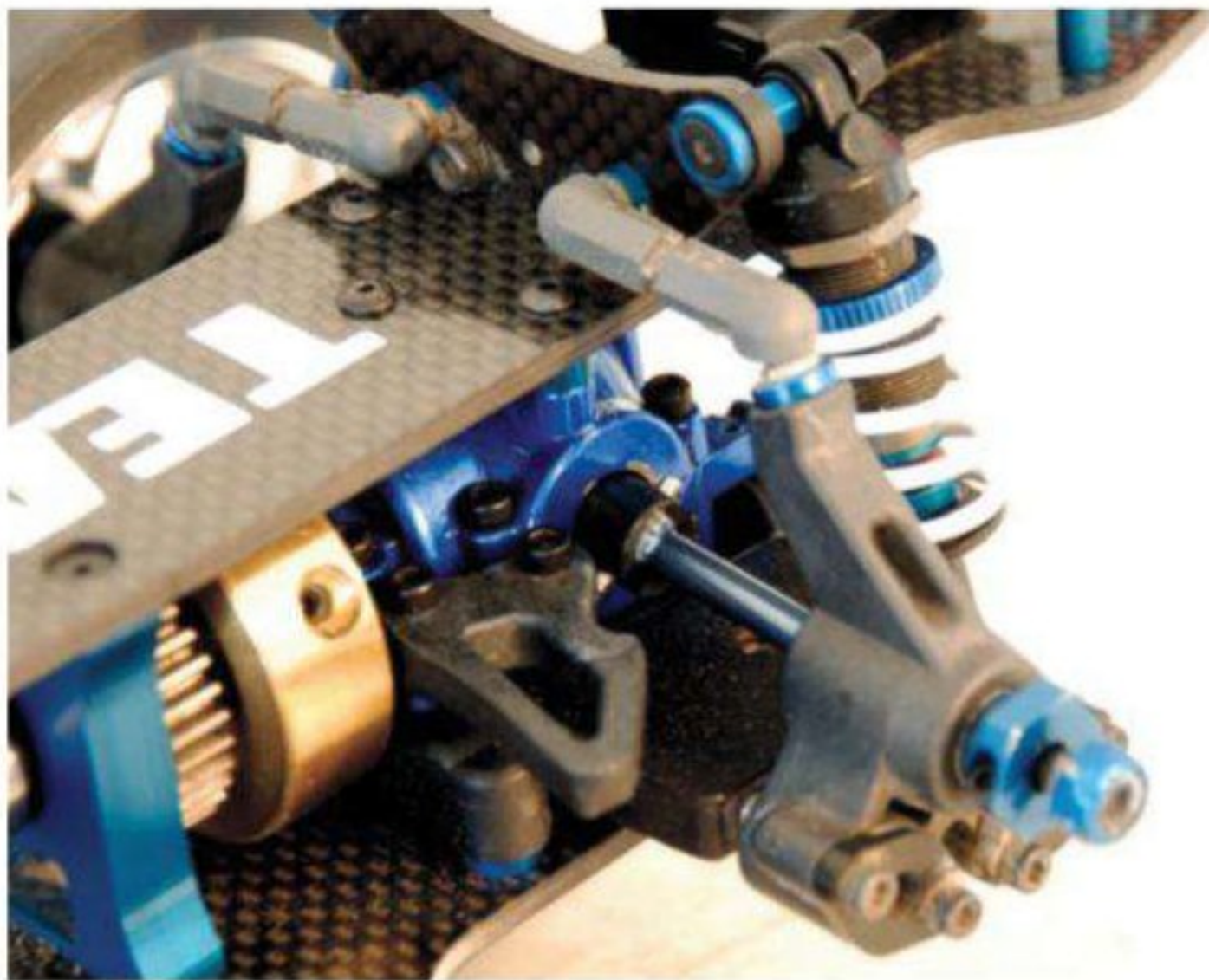
'Additional aerodynamic support was contributed by Dale Beever, a co-worker, who has had a lot of experience in the wind

tunnel with production vehicles. I'm pretty sure that the body thing is taken care of, but we won't know for sure until we go above 180. Right now we have only done 167. Even if it is just 186, 300km/h, I want to make sure we get everything out of the car that we can because we have never fully wound the car up yet. At these speeds, it is still accelerating, even on a full size drag strip.'

One of the problems that faced Case while developing the car was actually seeing it at those speeds. He came up with a fixed Long View Camera, which is used to monitor the car as it sets off at the start of the drag strip. Case then takes it up with the naked eye at full speed. 'We looked at putting the camera on the car, but it is not realistic because, while it sounds like a good idea, the camera is two inches off the ground and the perspective is so incredibly heightened in terms of difficulty.'

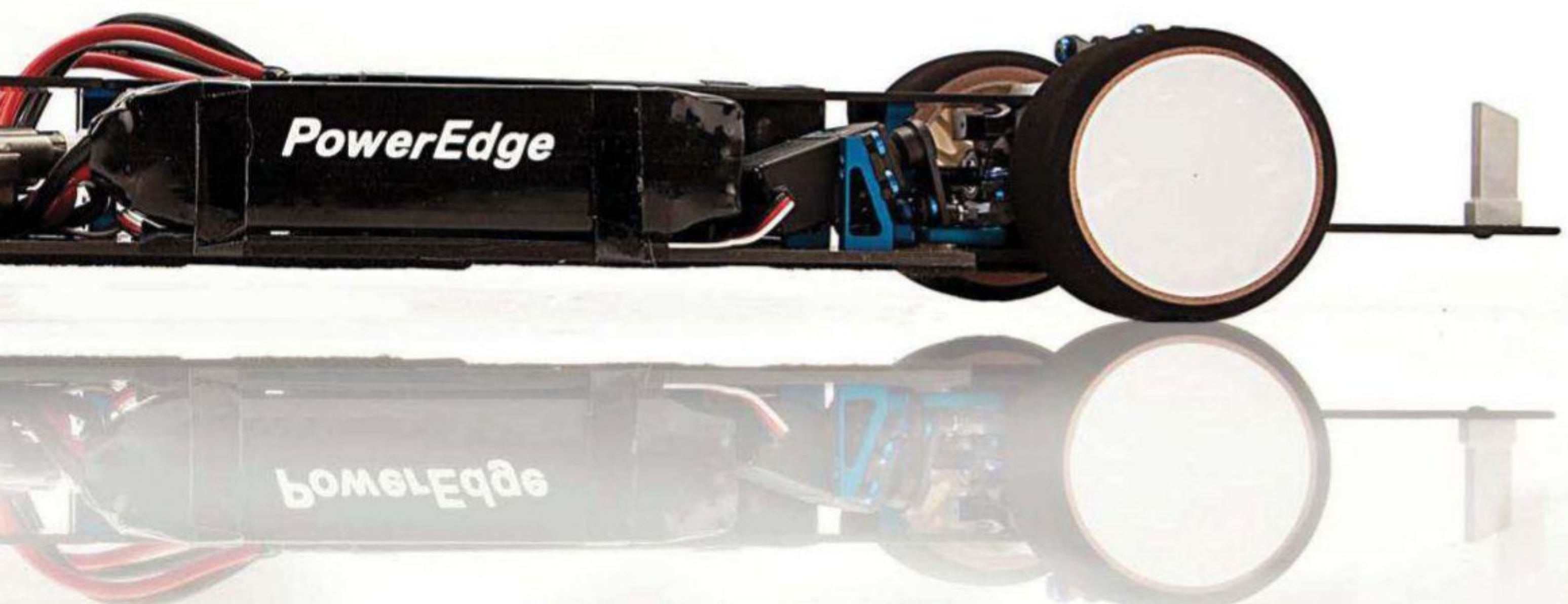


"the nose of the car was actually deforming at speed"



The level of detail that has gone into this one tenth scale model is extraordinary. The gear mechanism (top right) had to be specially machined from metal replacing the more commonly crafted plastic components. The entire car weighs just 13lb

“The original V1 body was inspired by the JCB Diesel-Max”





The SR11 has undergone CFD development, but Case found that this was no substitute for real-world testing, where nature came into play



Case's experience at Ford, where he works as a model maker, has helped him develop the SR11 into a potential speed record car

It would be possible to do but, with a camera that low, you would need side markers a mile long to be able to judge.'

PARTY CRACKER

Most people consider a radio-controlled car to be a toy, normally given for Christmas and birthdays, and it is hard to break away from that notion. The long list of technical innovation that has gone into the streamliner is enough to dispel such thoughts, however. Just as the outright land speed record cars have had to look at their wheels to run on hard salt, Case and his team has had to develop a wheel that will spin at 23,000rpm. They began with an off-the-shelf, vulcanised rubber construction fitted to a very successful carbon fibre wheel with cyanoacrylate glue, and then balanced.

'Tyres have been a big issue, but we think that has been solved now,' says Case. 'Another problem was the gears. The

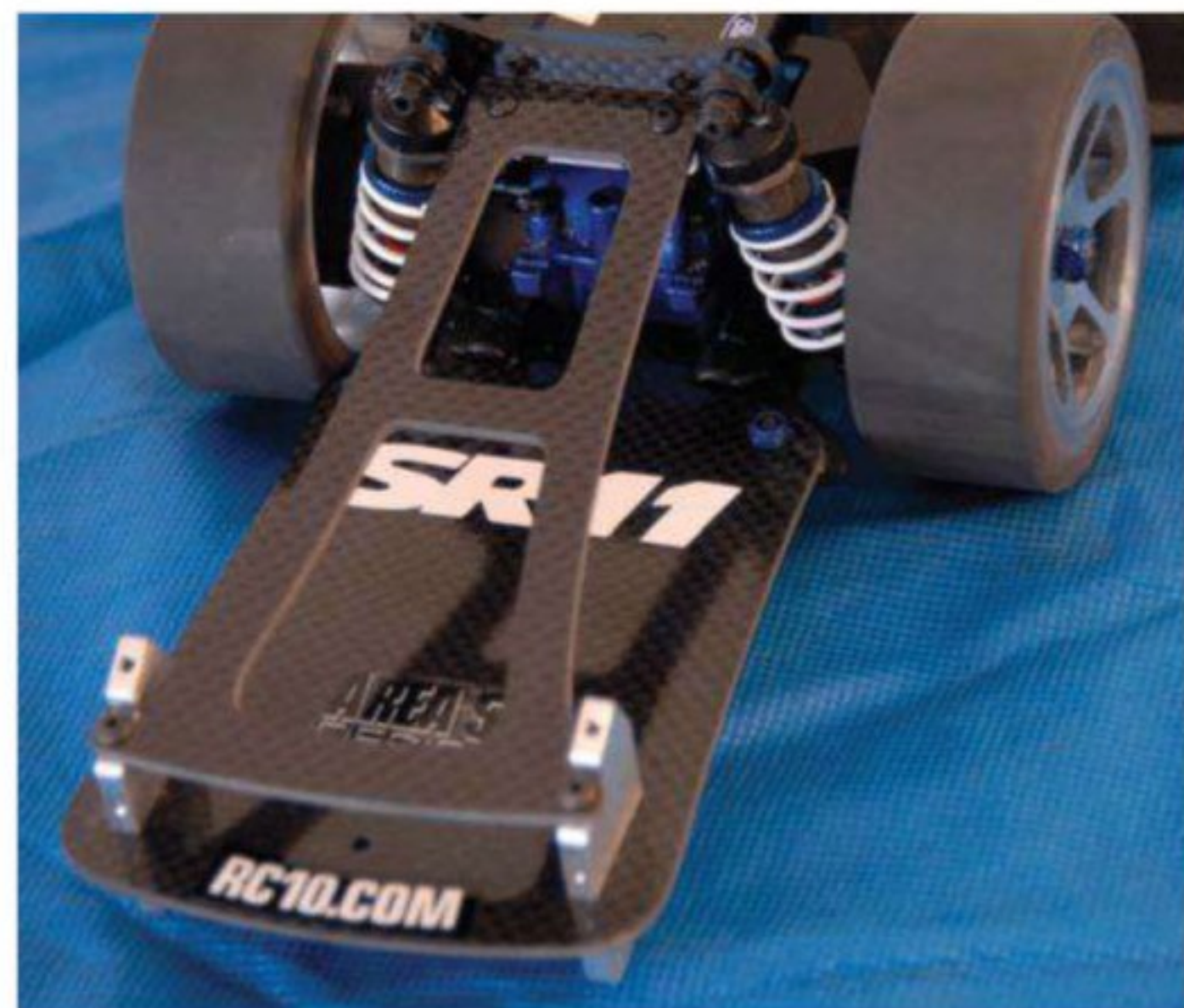
typical species of gears available in a one-tenth scale RC are made of plastics and softer metals. To handle the kind of power we are putting down, hardened steel gears are the solution for us.'

"The big unknowns right now are the aerodynamics"

The current car, named the SR11, is an Associated NTC3, narrowed and stretched. It is a four-wheel drive car, with independent suspension and shaft drive machined by Curtis Husting. The main shaft will have to spin at 57,500rpm at 200mph, one of the major technical challenges that face the team.

WEIGHTY ISSUES

The radio uses 2.4Ghz to control the car, similar to that used by computers. The transmitter and receiver have had to be placed as high as possible to achieve



Just as with the absolute World Land Speed Record cars, the SR11 has undergone extensive development work on its carbon fibre wheels



A reliance on the goodwill of more than 80 people weighs on the project leader's mind, hence the target to hit 200mph by March 2012

the range needed to get the car down a full length drag strip. The electric motor is brushless, 10 to 13bhp, more commonly used on RC helicopters and planes. It was designed by Steve

The speed is controlled by the electronic engineers at Castle Creations, who have created a unit that can handle 200amps and 50V. It can be programmed through a USB port on a laptop for timing and other fine-tuning adjustments. Batteries are lithium polymer from PowerEdge, and they are lightweight, delivering a massive amount of amperage. The batteries are currently 11 cells, but the team say they can go to 12 in future iterations of the racecar.

With all the effort put into creating a record-breaking car, the target is to set the record before March 2012. 'I am not taking for granted that we will be able to reach 200mph,' concludes Case. 'This is uncharted territory for a radio control car. I am sure that someone will break it. Our team has certainly put in the effort to be the first but, since records are made to be broken, I think this will be a never-ending story.'



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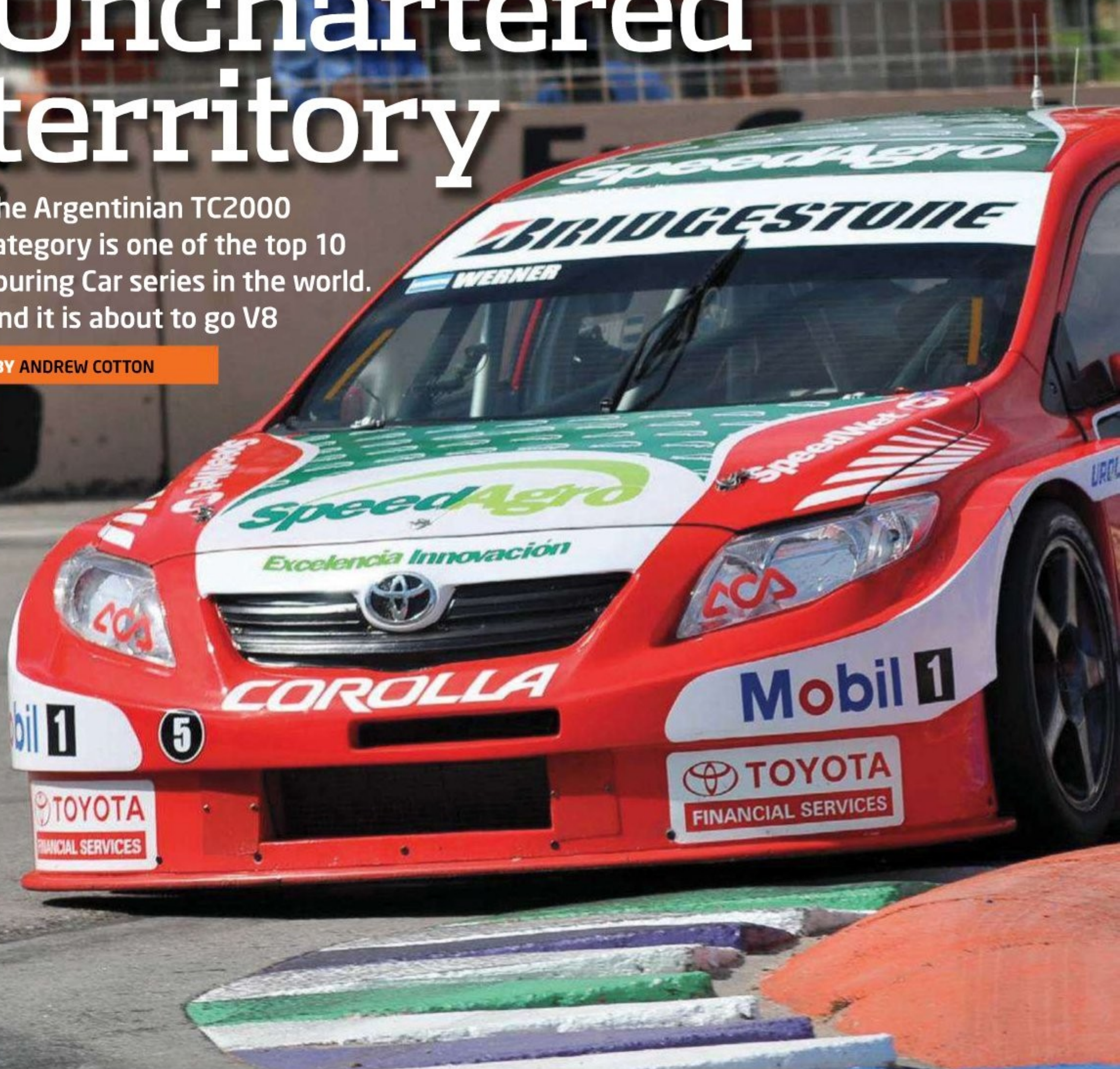
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ARGENTINIAN TOURING CARS

Uncharted territory

The Argentinian TC2000 category is one of the top 10 Touring Car series in the world. And it is about to go V8

BY ANDREW COTTON



The Argentinian motorsport scene may not have the variety of other countries, but what it lacks in variety it more than makes up for in depth. Its premier series is TC2000, contested by 43 cars, entered by seven manufacturers and a wealth of privateers. There are few other race series that can boast this level of involvement, and there are two more manufacturers, Citroën and

Volkswagen, who are looking to join in one of the most successful multi-brand formulae in the world.

The TC2000 championship has a huge following in Argentina and is rated as one of the top 10 Touring Car series in the world. It started in 1979, at the behest of Peugeot, Ford and Renault, who realised there was no production-based racing series in Argentina, yet there was a demand for just such. The first 'tournament' was held

in 1980, and won by Jorge del Rio in a Hillman Avenger, built by Chrysler in Argentina in the 1970s and later by Volkswagen.

In the early days, the criteria for who could enter were fairly clear. Any manufacturer that produced cars in Argentina would be eligible but, as the global market took over, that rule has relaxed slightly and now a manufacturer only has to produce a car in South America. That automatically eliminates BMW from the competition, but

Mercedes, for example, could enter as it builds the A class in Brazil, as well as trucks and buses in Argentina.

By law, a percentage of the manufacturer's income must also be spent on motorsport programmes. With General Motors, Peugeot-Citroën, FIAT, Ford, Honda, Renault, Toyota and Volkswagen all producing cars in the country itself, the potential for the TC2000 series is huge. Competing in 2011 were full factory teams from Ford,



"a manufacturer only has to produce a car in South America"

Honda, Toyota, FIAT, Chevrolet, Peugeot and Renault, and with drivers such as former Renault test driver, Jose Maria Lopez, and Norberto Fontana, the standard of the series is high.

TIP OF THE ICEBERG

In 2005, there were 10 manufacturers involved in the championship, and they took part in a race on the Rafaela oval circuit, the first front-wheel drive Touring Cars to do so. The fastest outright speed recorded

was 280km/h, but the economic downturn hit the series soon after, as it did others around the world. However, costs were escalating out of control. In 2003, teams were building three or four different designs for the front hub alone in an effort to find that competitive edge, and that was just the tip of the iceberg.

Until 2008, engine regulations were similar to those of Super Touring engines up to 1999, but there needed



Since 2008, all cars have been powered by a 300bhp, 2.0-litre, four-cylinder engine but, as of 2012, this will be replaced by a 430bhp, 2.7-litre V8 unit



Composite front end panels replace steel ones and beneath is a removable tubular structure that supports a double wishbone front suspension



With direct manufacturer competition costs started to spiral out of control, so a number of spec parts, such as brakes and suspension, were introduced.

to be changes, so the series organisers introduced a spec engine - a 2.0-litre, four-cylinder unit built by Oreste Berta. The engines produce around 300bhp and development on them is banned. However, more recently, the organisers decided that this is not enough, and in 2012 will introduce a new engine formula - a spec 2.7-litre V8. This is to be provided by British company, Radical Performance Engines (RPE), who will supply 42 TCX V8s in a three-year deal.

V8 TECHNOLOGY

The RPE TCX engine uses a 72 degree v angle and 32-valve, quad-cam, racing technology cylinder heads, mounted to a dedicated dry-sump crankcase, to develop 430bhp and up to 260ft.lbs of torque. A flat plane, steel billet crankshaft transmits power to the gearbox, while a gear drive rotates the Formula 1-specification scavenge pumps, twin oil supply pumps and coolant pump. RPE has constructed over 230 RP V8s since the engine's

launch in 2005, primarily for use in Radical's SR8 racecars, but also for applications as varied as autograss, hillclimbing, off-road and even Jet Ski racing.

'RPE is proud to forge a new relationship with TC2000, bringing the performance, sound and reliability of the RP V8 engine to a new audience,' said RPE director, Ted Hurrell. 'At only 88kg, the TCX V8 is one of the lightest and most cost-effective racing V8s on the market, and we look forward to supporting TC2000.'

The current spec sequential gearbox, provided by Xtrac, will be retained as it can cope with a power input of up to 600bhp.

ENGINEERING FREEDOM

The chassis is a mixture of the regular road car and a tubular frame. 'There is a lot of freedom in the car,' says Toyota Team Argentina director, Gustavo Aznárez. 'We can remove a lot from the base car, but not the roof, the doors, the rear sides, the floor. The front structure is absolutely removable, to make way for the tubular chassis.'

'The front of the car, the hood (bonnet), the fenders



With so many manufacturers competing, the grids are always full and, as this is Argentina's premier motor racing activity, crowd support is huge. Drivers can be paid more than their European sports car counterparts.

criteria, however, is not to use the original body as a structural member because the tubular chassis is near indestructible. If you have a problem you can just replace that part, so it is like brand new.'

"the manufacturers decide what can and cannot be raced, and what may be modified"

(wheelarches) and the front bumper and splitter are exactly like the original ones, but made in some kind of plastic, composite material. No metal, that is not allowed. You can modify the wheelarches to fit and to cover the racing wheels. The track is wider than the standard one, and it depends on the car. The total width of the car by regulation is 1900mm and the wheelbase must be 2600mm. That is why lateral covers over the wheels are different from car to car. This also relates to the rake of the car, to equalise the frontal section.

'The tubular structure is the chassis and the body is the safety cell. The bodies today from the standard cars are extremely safe and there is no point in changing that. Our

ON COMMISSION

So many competing makes is normally a recipe for disaster, as each is looking for the performance advantage and costs can quickly escalate. As tried by the World Touring Car Championship, the manufacturers sit on a commission, called Inter Fabrica, and they decide what can and cannot be raced, and what may be modified. The commission's primary focus has been to contend with controlling a multitude of manufacturers.

When Peugeot wanted to enter the 307, a two-box design, the commission had to decide what to do with the car to make it competitive. It was the same dilemma faced by the Touring Car Commission when SEAT wanted to switch to the Leon, and the



Feature races make up half of the season, and can take place on street tracks, be in endurance format, and can include pit stops and driver changes

solutions are fairly similar - play with the rear wing. In TC2000, the chord lengths and location are fixed, but not the shape of the wing. The hatchbacks get different location limits.

'There is not only a cost objective,' says Aznárez, 'this is a competitive category with clear rules. The rules are the same for everyone and, while cost is always in mind, we all love the big technology and there is no limit in money. I will spend every dollar that I have, it is part of my job, but the category and the rules mean that is unnecessary because, by regulation, the cost is kept as low as possible.'

The cars start life as standard

production cars and are then stripped out and prepared for racing. The front suspension is adapted for a double wishbone layout, while the rear is fixed beam. The springs are free, the anti-roll bars are free and, while there is a spec damper, the internals are also free. The location of the A arms, dampers and anti rollbars is free, and the series has spec brakes and engine management control units - to be expected with a spec engine - while the data acquisition comes from MoTeC and AIM. Anti-lock brakes and traction control are both banned from the series, ensuring some spectacular racing.



Body modifications are essentially free, with just a mandated total car width of 1900mm. The results are some pretty dynamic solutions

PENALTY POINTS

In an effort to maintain close racing, the commission spent a lot of time working on the sporting regulations and came up with some ingenious, if mind-boggling solutions that would drive any commentator to distraction. There is a regular race format, and a special, which could be on a street track or endurance format. For the regular races, in qualifying, the championship leader is penalised 12 places on the grid for the first race. Second place in the championship is penalised 11 places, and so on through to 12th place in the championship.

The grid is then separated into odd and even numbers, and have a short race – five laps around the San Luis circuit in November. The fastest race winner takes pole position for the Final, the fastest second place finisher takes second, and so on.

In the special races, designed to jazz up the racing even further, no championship penalisation takes place, but the

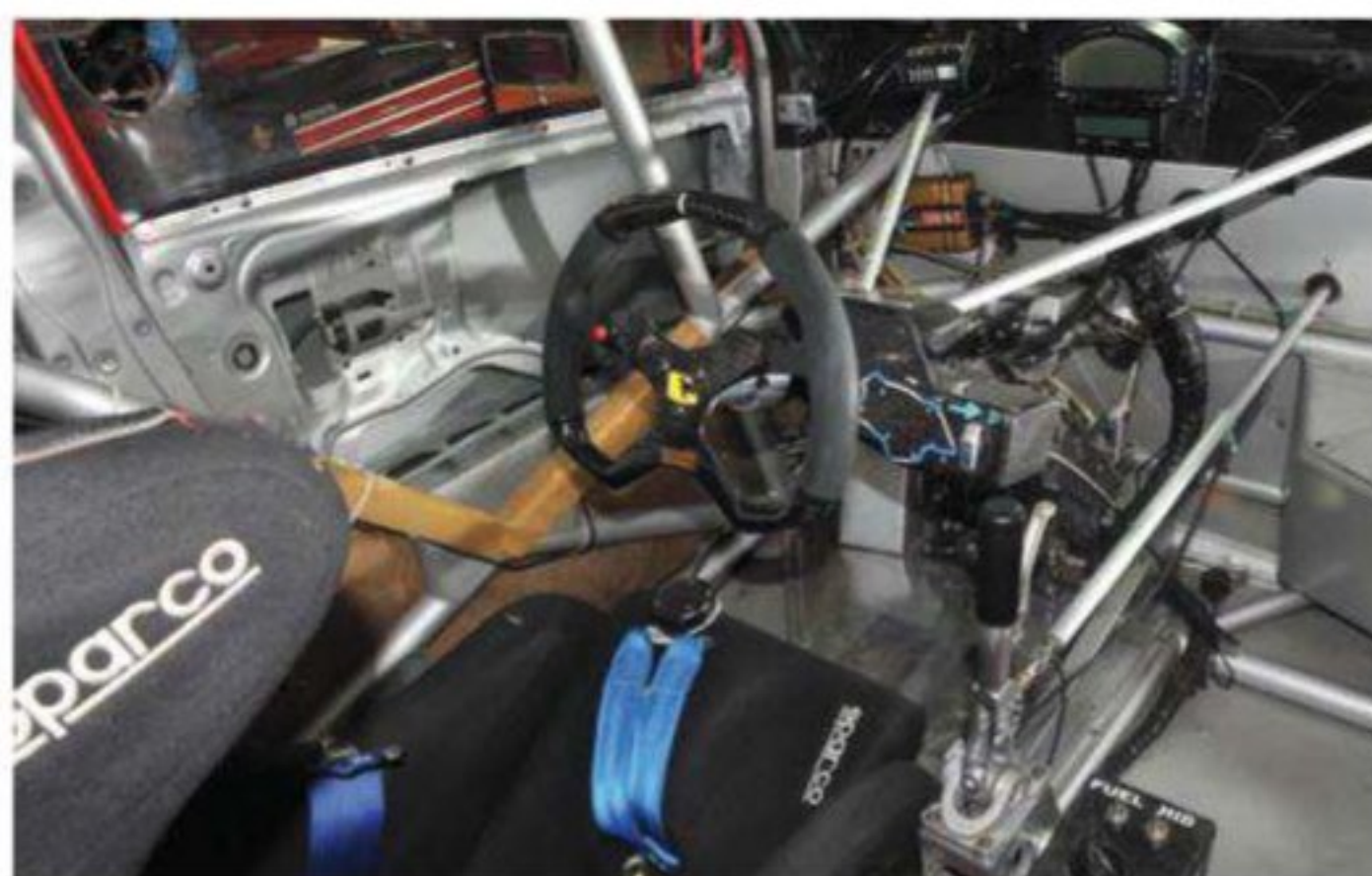
teams may have to change tyres, drivers or refuel. It is all designed to give the spectators a show, with championship contenders battling mid-field, and the less successful teams offered the chance to run at the front, and potentially even win races, satisfying their sponsors.

Six test days are allowed during the season, called

community test days, and again the championship leader is penalised. He is allowed to run at full engine revs for only five minutes during the test session, while the second place car can run for 10 minutes at full power and so on. After that, they are limited to running at 5,500rpm for the remainder of the test session, so development potential is relatively pointless.

'It limits the costs, and limits

"some ingenious, if mind-boggling solutions"



Office is dominated by the rollage structure, with the driver positioned well back in the car. Xtrac sequential gearbox is to be retained with the V8



'There is a lot of freedom,' says Toyota Team Argentina director, Gustavo Aznárez. 'We can remove everything... you can do a lot of modifications'

the opportunities,' says Aznárez. 'At one point in the middle of the season, my driver was leading the championship by 50 points. 50! It was like Sebastien Vettel and the championship should have been over. However, we could not do any more meaningful development and now the lead is only three points, and third place is seven points behind. As a team

manager, I don't like it, but it does create a close end to the season.'

Tyres are provided by Pirelli and teams are limited to one new set per test day, and eight new tyres for a race weekend. Teams can play with the ride heights and rake of the car to balance out the drag coefficient, allowing even the worst concepts to compete on a level playing field.

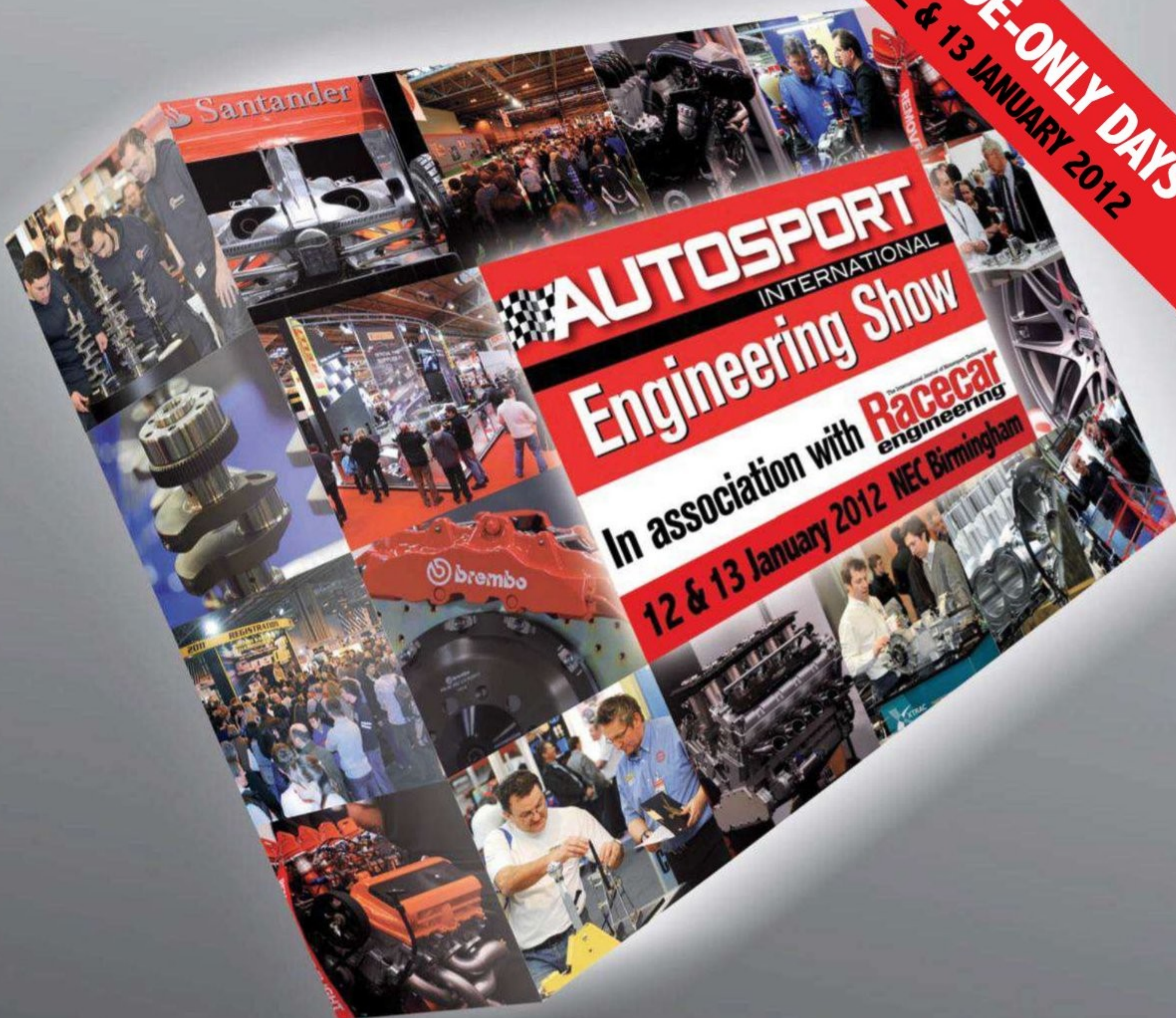
If the qualifying procedure seems complicated, the entry

criteria into the series is even more vague. The cars must belong to the same segment of the market, and entry to the series is at the behest of the commission. If Toyota wants to bring its Corolla to compete with the Volkswagen Bora, or the Honda Civic, it would be accepted. If Toyota wanted to switch to the Avensis, however, the commission can turn it away... unless the manufacturer really needs to push the brand. When Chevrolet first started in the series it ran the Astra but, when marketing needs required them to look at an alternative, organisers allowed them to switch to the Vectra. 'You can come with the same power and have the same opportunities, but you cannot have an advantage,' says Aznárez.

With a die-hard international following and a dedicated and enthusiastic audience at home, TC2000 is undoubtedly one of the best Touring Car series around today, and only looks to be getting better.



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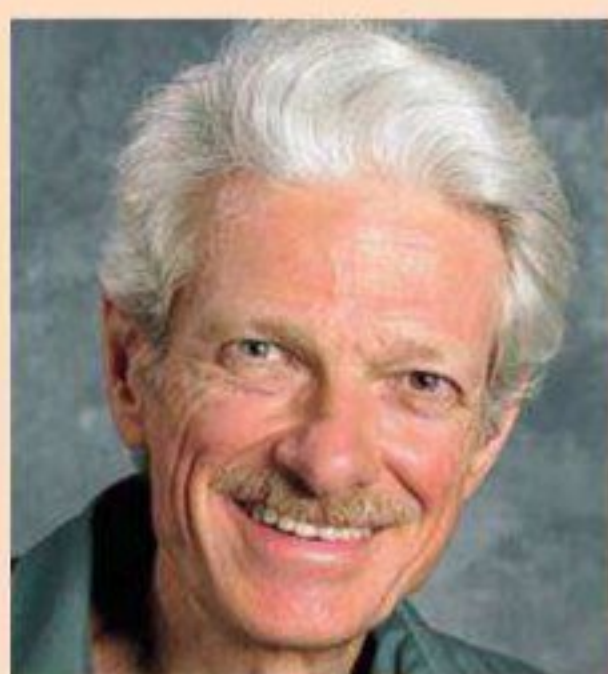
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Doing the twist

Improving a production live axle rear suspension

Q Over here in Australia we have a race class called Improved Production. A popular car is the Gen 1 Mazda RX7 with a live rear axle.

The rules say the suspension must retain all the original links and that all bushes must be elastomeric, so no spherical bearings are allowed. Additional longitudinal links are permitted and lateral location devices are free. Conventional wisdom says that the original links are prone to binding (they consist of parallel lower trailing arms and shorter upper arms about 10in long and angled inwards towards the front). Most

people use very soft bushes in the top arms and add another set of parallel top trailing arms, but my question is this: the track is about 60in so, if the outside suspension is compressed, say, 3in in a corner and the inside extends 3in the total difference is 6in, giving an axle angle of about six degrees compared to the chassis. I accept that this would twist the suspension arms and perhaps cause binding, but would the degree of twist not be the same in the new parallel top arms as well? And does the fact that the original top arms are angled make the situation any worse?

For readers unfamiliar with this suspension, it has four trailing links for longitudinal location and torque reaction, and a Watts linkage for lateral location. The upper trailing links do splay out a bit at their trailing ends, mainly just to clear the springs. This is not, however, a triangulated four link, where the link angles in plan view are sufficient to allow the four links to provide lateral location without any other mechanism.

The upper links are much shorter than the lowers. This is partly for packaging, but also it makes the side view geometry (and, accordingly, the anti-squat and anti-lift) roughly in accordance with Olley's Rule: that is that link lengths should be inversely proportional to their height above ground. This makes the longitudinal antis roughly consistent, regardless of ride height.

The problem is the side view swing arm length fluctuates with suspension displacement. Depending on where the suspension is in its travel range, the longitudinal links try to rotate the axle housing forward with compression, or rearward, or neither, at a varying rate. In ride, no problem, but in combinations of ride and roll, the longitudinal links on each side of the car try to rotate the axle housing different amounts, and / or in different directions. Any time the links try to create differing rotational displacements of the housing, they effectively turn the housing into an anti-roll bar.

This might be lived with if the effect were consistent (the car has a rear anti-roll bar, so eliminating roll resistance is not the point), but the problem is that this component of roll resistance varies erratically in different combinations of ride and roll displacement. In a straight line,

the system behaves well, even if the surface is undulating. And in cornering, it also behaves well, as long as the surface is smooth. However, when presented with hard cornering and a bumpy or undulating surface at the same time, the system produces capricious variations in roll resistance distribution.

It is true that any cylindrical bushing only allows torsional movement by deforming, and that is inescapable if sphericals are prohibited, but that is not the main problem with the stock layout. In the US, at least under SCCA rules, bushing material or construction is entirely free, but the links still have to be there. It is, however, permitted to add 'traction control devices'. The most common approach therefore is to use either urethane bushings or spherical bushings in the lower links, replace the bushings in the upper links with foam rubber, and add a single new central upper link, bent to clear the driveshaft tunnel. This effectively converts the suspension to a three-link design with a Watts linkage for lateral location.

That does at least make the system consistent. It doesn't eliminate torque roll, which should be an objective in any live axle suspension design, but it does solves the most urgent problem.

"the system produces capricious variations in roll resistance distribution"



Gen 1 RX-7 has a beam rear axle. Adding a further pair of parallel links won't improve it much, but a single, central third link makes it more consistent

Back to school

Where to look first to improve your car's general set up

Q I am an avid BMW CCA club racer. I have progressed quite far and have even won my championship a few times. However, there are still a couple of guys that I just can't catch. Other than money, I think one of the reasons they are beating me is set up. They are very good at nailing a set up for a given track.

I have a good baseline for my car, which was given to me. I soften it a bit for bumpy tracks like Mosport or Sebring, but otherwise pretty much stick to it. Once in a while, all the planets align and I set a lap record, but it's always a surprise to me. I call this my little set up lottery.

I am an engineer by schooling (electrical). I have come up through the BMW and Porsche clubs where I have been instructing for years. I understand all the underlying principles and have read all the books. But I have no idea how to unite them all into a unified theory of suspension set up. In this respect, I am quite typical of club racers and probably a good chunk of your readers.

Do you think you can give me some guidance toward developing my set up skills? Where should I look?

My car is a BMW E36 M3, 410bhp, 2200lb, Moton three-ways, slicks etc.

I don't see any way to reduce something this complex to a brief set of principles or rules, especially if those have to apply to a wide variety of vehicles. For production-based cars with tightly regulated bodywork, it does get a little simpler than for winged cars, because at least we aren't dealing with dramatic variations in the aero properties, but even then it isn't simple.

One universally applicable principle would be to know why

you are trying a given set up change. What are the physics? What exactly are you trying to make the car do or not do?

The basic idea of having a baseline set up and softening it a bit if the track is rough makes sense. Depending on the car and the rules, it is often necessary to use higher static ride heights for the softer set up.

In addition to general roughness of the track, factors that may influence set up include:

- **Dominant turn direction.** Some tracks have most of their turns in the same direction
- **One or two turns being more important to lap time or passing opportunities than the rest.** Most commonly, such turns are at the beginning of major straightaways
- **Predominance of tight turns or sweepers**

Issues such as these become

particularly interesting if we have ballast we can move. Production-based cars may or may not have ballast, depending on the rules.

When one turn direction is dominant, or when one turn is unusually important, sometimes it pays to move ballast toward the inside of such turns. It may cost us elsewhere in the lap, but we may come out ahead overall.

When there are lots of short-duration tight turns, braking before those turns and forward acceleration after them become more important, and mid-turn speed becomes less important. With rear-wheel drive, more rear percentage will help the car put power down, and will also shorten braking distances.

When there are a lot of sweeping turns, and few long straights and tight turns, it may pay to move ballast forward a bit more, to work the tyres more evenly in steady-state cornering.

With live axle rear suspension, it can help to use a bit less than 50 per cent diagonal (meaning LR + RF) to compensate for torque wedge. If the turn before the most important straight is a tight right-hander, there is a case for being a bit more aggressive with the diagonal.

But again, in all of this, it is of paramount importance to know what one is trying to achieve, and have a clear understanding of how one expects a set up change to accomplish that.



The most important thing in any set up is to know what you are trying to achieve and how you expect to achieve it

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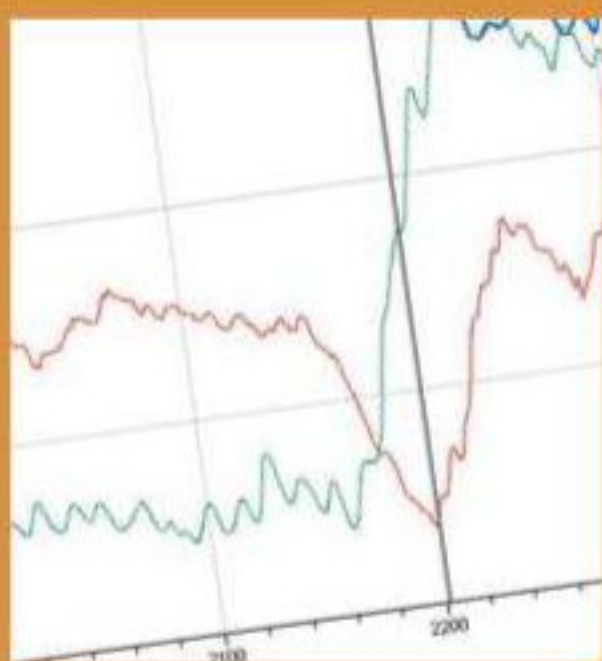
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Databytes gives insights to help you improve your data analysis skills each month as Cosworth's electronics engineers share tips and tweaks learned from years of experience with data systems. Plus we test your skills with a teaser each month

To allow you to view the images at a larger size they can now be found at www.racecar-engineering.com/databytes

Challenge Cosworth

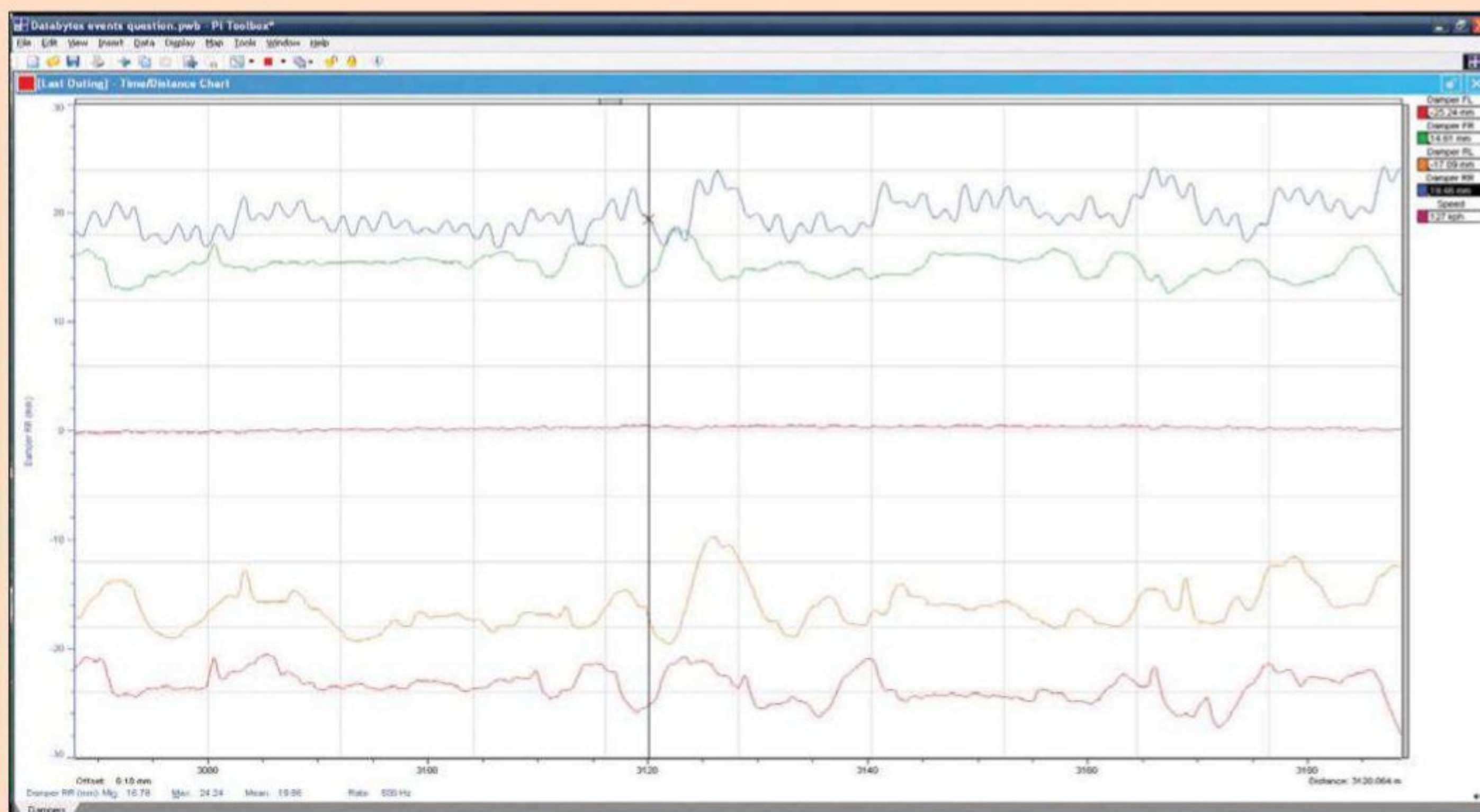
Test your data analysis skills with this series of questions set by the data engineers at Cosworth

Databytes is a little bit different this month as we have launched a new section on the *Racecar Engineering* website dedicated to the ever-popular challenges. We will

continue uploading new challenges and invite you to discuss the answers. We will also be offering a range of great prizes for some of the challenges so remember to keep checking back. But for now, test your analysis

skills with these three challenges set by our partner, Cosworth Electronics. The answers will be posted online at www.racecar-engineering.com/databytes. Databytes will be back as normal next month.

CHALLENGE 1



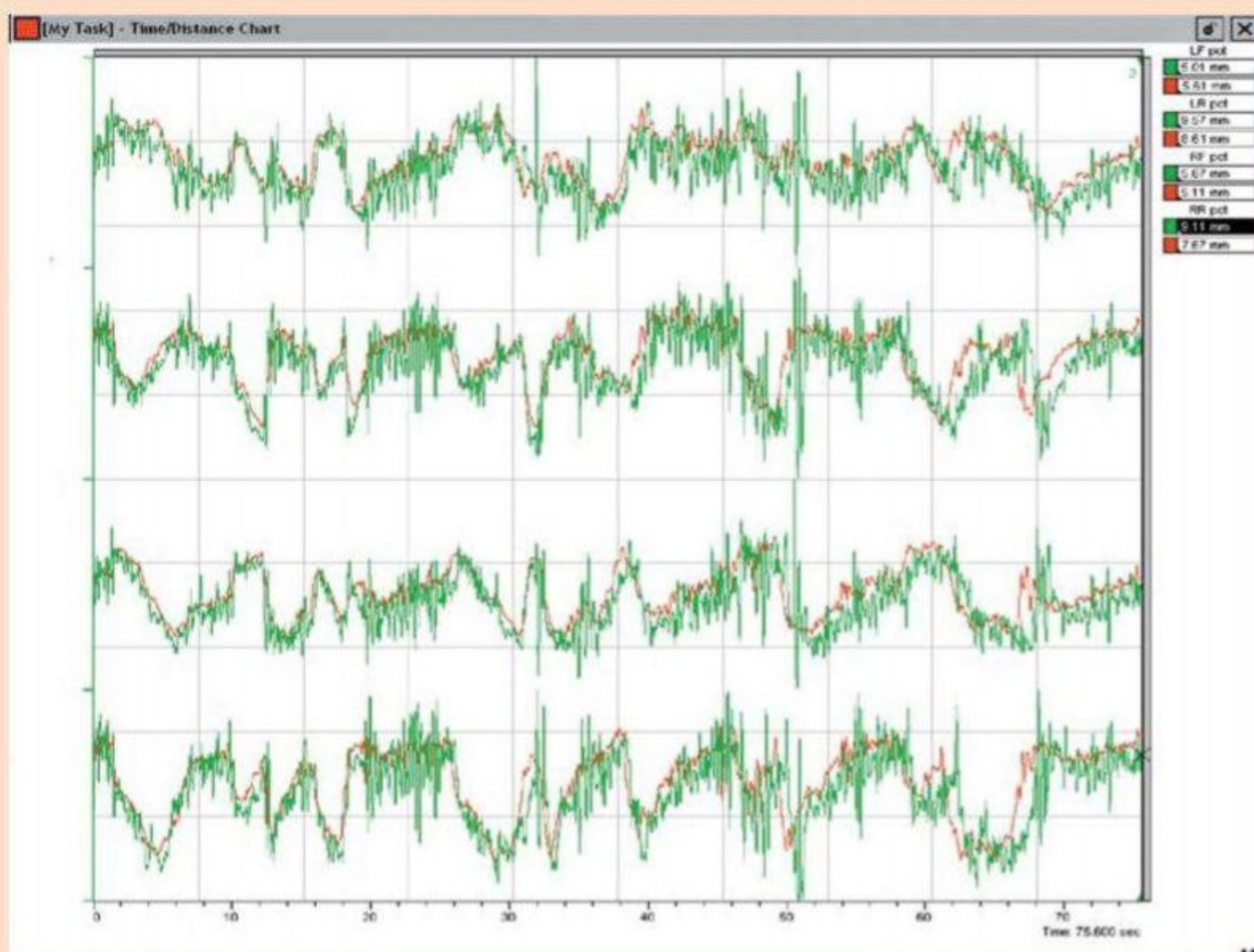
The image shows a close-up of damper traces at a section of track. The RR Damper signal is markedly different to the others which show the same trend. What is the reason for this?

- The tyre has a flat spot.
- The car is driving on a kerb.
- The sensor is damaged.

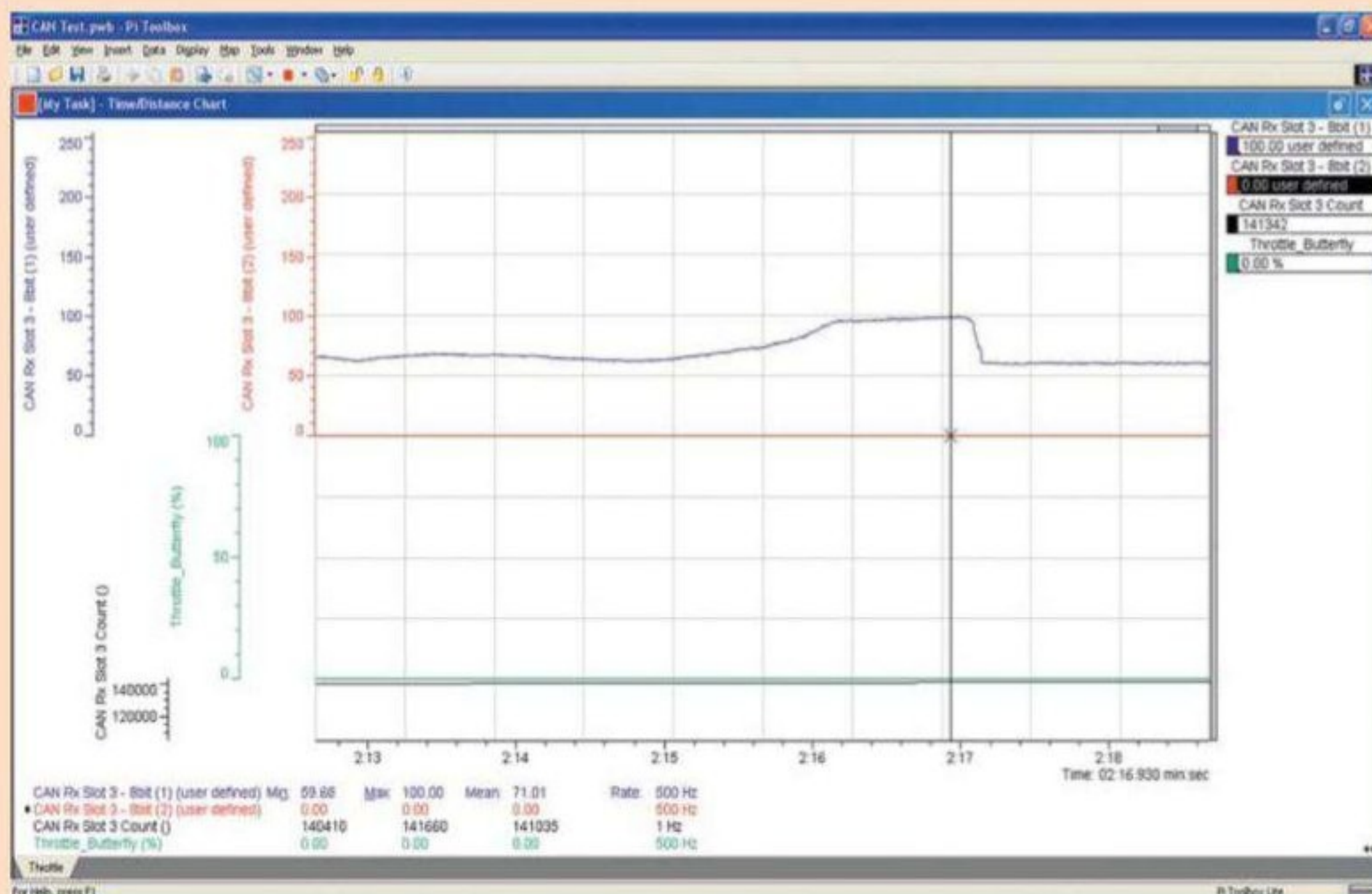
CHALLENGE 2

The traces display the damper displacement for a team's two cars. The red car has produced good damper traces. However, although the green car's traces show a similar trend, they are very noisy. What is causing this problem?

- All four damper pots on the green car have failed.
- A fault within the green car's loom means that the damper signals are not grounded.
- The sensors are loosely mounted on the green car.



CHALLENGE 3



The enclosed shows a bench test which is being performed on a data system connected to an ECU. Calibration of the CAN data stream from the ECU is being carried out, and when this screenshot was taken, the throttle butterfly potentiometer was being tested across its full range, 0-100%.

The calibrated channel called "Throttle_Butterfly" - where 1 count equals 1% of calibrated

movement - does not appear to be correct. Given the screenshot, what is the most likely reason for this?

- The ECU is not turned on and no CAN data is being received
- The calibrated channel is referencing the incorrect byte in the CAN packet
- Throttle is not connected

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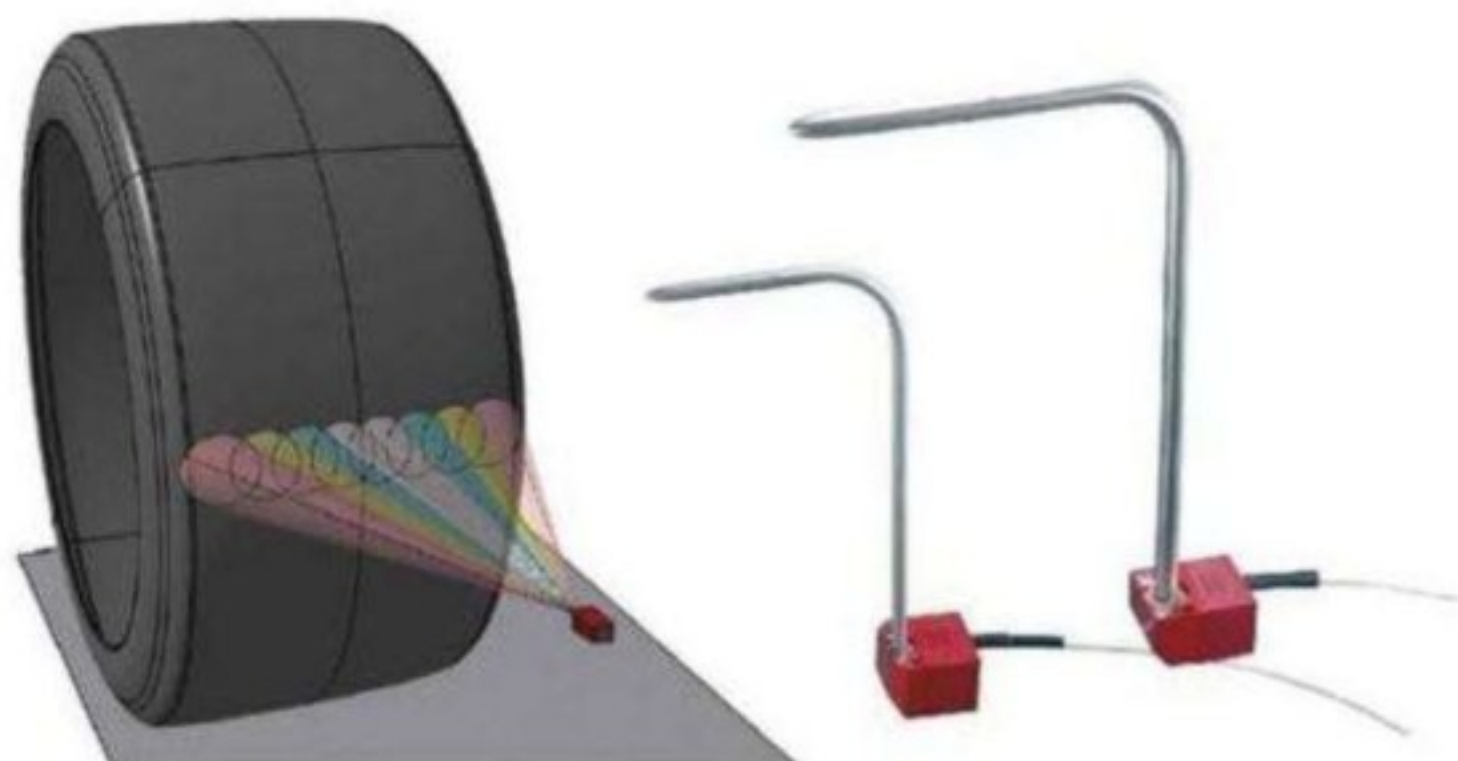
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Simon McBeath offers aerodynamic advisory services under his own brand of SM Aerotechniques - www.sm-aerotechniques.co.uk. In these pages he uses data from MIRA to discuss common aerodynamic issues faced by racecar engineers

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Observations on two sports racers

Validating the figures for the Arachnid and Force LM

Continuing with our examination of two distinctive sports racers, the Arachnid closed coupé circuit racer of CTR Developments and the Force LM hillclimber of Force Racing Cars, we conclude with a look at some interesting details divined in the MIRA full-scale wind tunnel.

The first task with any racecar we test for Aerobytes is to run first at 60mph (approximately 26m/s) and then at 80mph (approximately 35m/s), which is the maximum speed available. If the flows around, over and under our racecar are similar at both speeds then the calculated coefficients will be the same at both speeds. Sometimes, though, the coefficients are different at the two speeds because attached flows have not fully developed at the lower speed, in which case the higher speed is used for subsequent runs. If the coefficients are the same then the lower speed can be used because it requires less power, and runs can be completed a little faster because it takes less time to accelerate and decelerate the air for each run. We generally use the maximum speed for Aerobytes, but the checks at the two speeds can prove interesting.

The results at the two speeds on the Arachnid and the Force LM during their start of session baseline runs are shown below in tables 1 and 2. The changes to the coefficients are expressed in 'counts', where a coefficient change of 0.100 = 100 counts. The Greek letter Δ (delta) represents the change to each parameter as a result of the configuration adjustments, in this case a speed adjustment, relative to the previous configuration.

Clearly, something different was going on with the two cars here. The Arachnid produced lower negative lift (downforce) coefficients front and rear at the higher speed, whereas the Force produced higher negative

lift coefficients at the front and lower at the rear at the higher speed. Both cars produced slightly lower drag. The effect of different speeds on the Force was more akin to most cars we have tested for Aerobytes. And the most likely explanation here is that the flow under the front wing was probably not fully attached at 60mph, but it was at least better - if not necessarily fully - attached at 80mph. This effect can occur simply because of the sensitivity of front wings to ground proximity, and it may also be related to the development of the boundary layer, in spite of the wind tunnel's boundary layer control fence, ahead of the front wing,

Table 1 - the coefficients on the Arachnid at 60mph and 80mph

	CD	-CL	-CLfront	-CLrear	% front	-L/D
60mph	0.5385	1.1480	0.1355	1.0125	11.80	2.132
80mph	0.5340	1.0835	0.1145	0.9685	10.57	2.029
Δ , counts	-4.5	-64.5	-21.0	-44.0	-1.24	-103.0

Table 2 - the coefficients on the Force LM at 60mph and 80mph

	CD	-CL	-CLfront	-CLrear	% front	-L/D
60mph	0.6850	1.2335	0.6860	0.5475	56.10	1.783
80mph	0.6755	1.2625	0.7250	0.5385	57.43	1.869
Δ , counts	-9.5	+29.0	+39.0	-9.0	+1.33	+86.0

NB: coefficients are only reported to three decimal places. These figures are the means of two runs per configuration



The Arachnid's coefficients changed as speed was increased



The Force LM responded differently as speed was increased

which could exacerbate this. The small gain in rear negative lift coefficient may just be a mechanical leverage effect but, as we saw in an earlier episode, the flow off the Force's front wing impinged on the rear wing, so this may have been involved as well.

The change to the Arachnid's numbers front and rear is probably also related to flow attachment, but here it is more likely we are seeing the effects of the flow over the upper surfaces becoming better attached at 80mph than at 60mph, which would create a greater increment of positive lift from the body, manifesting itself as slight reductions in negative lift coefficients.

In both cases, better attached flows would explain the small reductions in drag coefficient.

ARACHNID ROOF LOUVRES

One of the details added to the Arachnid prior to our session was a set of louvres in the cockpit roof (designed to try and improve cockpit cooling), along with others down the spine of the engine cover to aid heat rejection from the engine bay. The results of removing and taping over first the roof louvres and then the engine cover louvres are given in table 3, below.

We can see that by removing the roof louvres alone decreased downforce and drag, suggesting flow attachment was better, but the net effect was increased

body lift. But then removing the engine cover louvres as well caused a small net gain in downforce with very little change in drag. This suggests a combination of increased body lift and reduced body drag, together with an improvement in rear wing downforce and the attendant increase in induced drag. Perhaps then, this wing downforce increment slightly outweighed the body lift gain, but with total drag remaining practically unchanged overall.

FORCE REAR END

Last month we saw that increasing the angle of the Force's lower rear wing (a single element device) had a pretty modest effect. To evaluate whether the device was contributing anything significant at all, it was removed totally, which produced the results shown below in table 4.

This certainly confirmed that the lower rear wing was doing a very useful and very efficient job! Interestingly though, the significant downforce increment it generated was felt entirely at the rear, whereas it might have been expected to aid the underbody and hence benefit front downforce, too. Why this should be so is not entirely clear,

but it may be that the diffuser's quite modest roof angle means that its exit is too far from the lower rear wing to enable any tangible interaction.

Racecar Engineering regulars will recall that we have carried out simple CFD studies on rear wing end plate depth in the past, which supported the perceived wisdom that deeper is better, up to a point. With minutes of this wind tunnel session left, a pair of cardboard end plate extensions that added approximately 250mm extra depth were hurriedly knocked up and evaluated. The effects are shown in table 5.

The gain in rear downforce, which amounted to 7.8 per cent, was obviously very useful, and it came with an efficiency of 63.5 counts of total downforce to 19 counts of drag, or 3.34:1. Furthermore, the extra rear downforce increment allowed a last minute front flap adjustment that brought the balance back into the 34-36 per cent front target zone and yielded the highest downforce and highest efficiency, most balanced set up of the entire session - a very satisfactory conclusion!

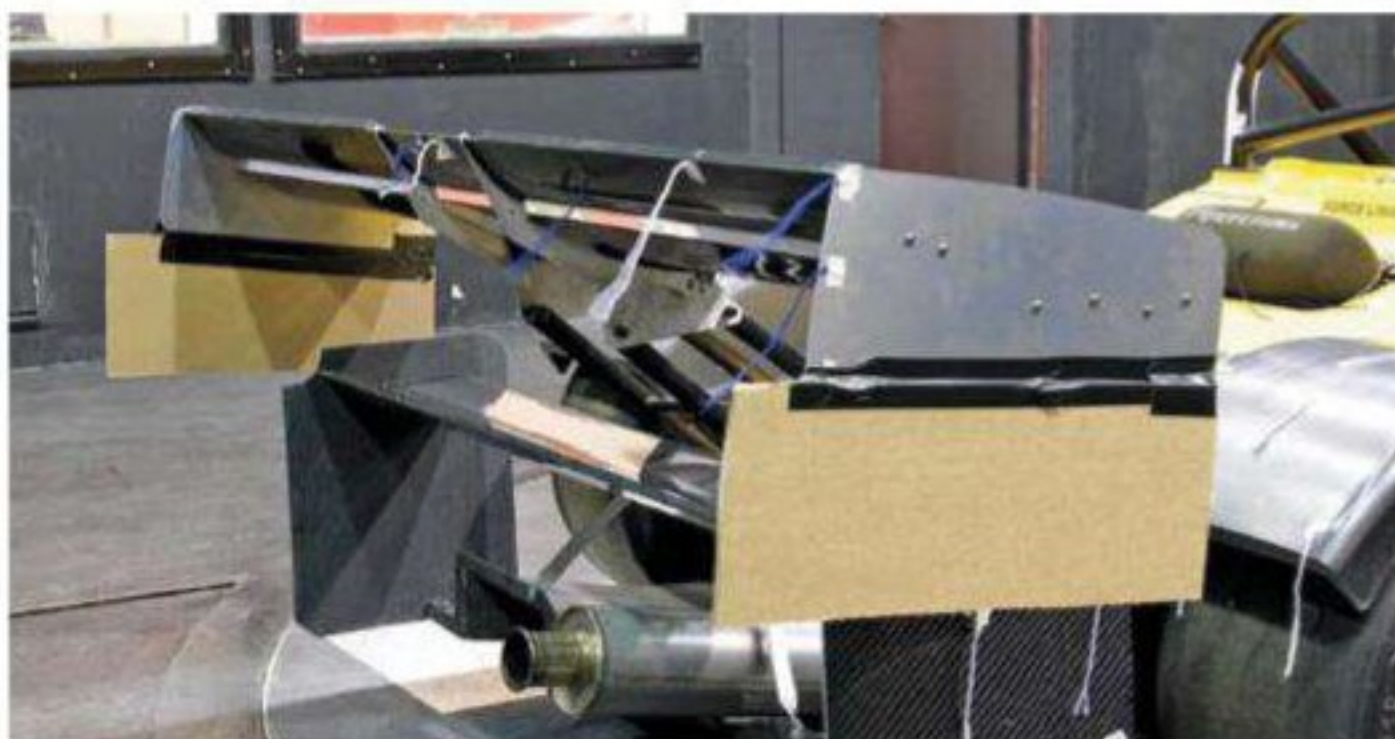
Thanks to CTR Developments, Force Racing Cars, Graham Wynn



The Arachnid's roof louvres influenced both downforce and drag



Removing the Force's lower rear wing made a big difference



Deeper rear end plates proved effective, despite the rapid prototyping...

Table 3 - changes to coefficients (in counts) on the Arachnid when roof and engine cover louvres were removed and taped over

	ΔCD	ΔCL	ΔCL_{front}	ΔCL_{rear}	$\Delta\% front$	$\Delta L/D$
Roof louvres	-16.5	-23.0	-8.0	-15.5	+0.26	+24.5
+ E/cover louvres	-1	+7.5	-3.0	+11.0	-0.71	+22.0

Table 4 - the effects of removing the lower rear wing element

	ΔCD	ΔCL	ΔCL_{front}	ΔCL_{rear}	$\Delta\% front$	$\Delta L/D$
Remove lower r/wing	-34.0	-195.5	+46.0	-241.5	+9.165	-178.5

Table 5 - the effects of adding approximately 250mm rear end plate depth

	ΔCD	ΔCL	ΔCL_{front}	ΔCL_{rear}	$\Delta\% front$	$\Delta L/D$
+250mm EP	+19.0	+63.5	-13.5	+77.5	-2.245	+104.0

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Set-up referencing

The 2D tyre modelling conundrum, and how to fix it

Over the last couple of months I have been involved in a number of diverse car modelling projects, from Stock Cars to open wheelers, and I have seen the same themes emerging. Principally, when using a 2D tyre model (traction circle radius as a function of load only) you have correlation, but the sensitivity of the model to very fine changes is extremely small. The trends still point you in the right direction, so it's still useful, but the changes are much smaller than what you would see on an actual car. The purpose of this article is to explore why this is, and propose a simple fix for it, that I will term set-up referencing.

BY DANNY NOWLAN

Let me add from the outset that this is an article designed to get you thinking, not the final word on how to model a tyre. Consider this a discussion paper on the mechanisms that drive what we see when we make a set up change on a car.

The crux of the 2D tyre model is effectively determining the traction circle radius (or Pacjeka D term) as a function of load only. This can either be done from tyre test rig data or using the ChassisSim tyre force modelling toolbox. If done right, you should be looking at a correlation something like shown in figure 1.

Remember, when you create

a 2D tyre model you are taking a snapshot of the tyre at a particular pressure and internal temperature condition. This is illustrated in figure 2.

Where 2D models struggle is sensitivity. Let's illustrate this with some hard numbers, in this case, from a V8 Supercar (see table 1). A representative 2D tyre model is shown in table 2. Now that we have this information, let's explore some set up sensitivity parameters. One big change in a V8 Supercar is a rear roll centre change. Typically, 10mm will produce a measurable change. To keep things simple, let's apply a lateral acceleration of 1.4g and use this acceleration to estimate tyre loads and

approximate cornering force. The results are shown in table 3.

What is presented in table 3 is a very simplified analysis. We are simply taking a static weight and applying a load transfer to it for a typical low-speed corner. What is revealing is that while the speeds are representative and the magnitude of the change is very small. With the 10mm rear roll centre change, the tyre loads have changed by a mere 3kg, and the speed has changed by 0.2km/h. Yet, in practice on the car, you'll typically see a change of 0.4-1km/h. The truth, then, is somewhere in the middle, but this illustrates well how a 2D model gives you a good broad brush stroke, but lacks fidelity.

Equations

1

$$F_y = k_a (1 - k_b \cdot F_z) \cdot F_z$$

$$L_p = \frac{1}{2 \cdot k_b}$$

k_a = initial coefficient of friction

k_b = drop off of coefficient with load

F_z = load on the tyre

2

$$A_{c,p} = \frac{F_z}{P_T}$$

$$l_{c,p} = \frac{A_{c,p}}{w_t}$$

$A_{c,p}$ = contact patch area (m²)

F_z = vertical load on the tyre (N)

w_t = width of the tread (m)

$l_{c,p}$ = length of the contact patch (m)

3

$$\mu = fn(P_L, V_s, T_{INT})$$

μ = coefficient of friction of the tyre

P_L = local tyre pressure applied at the tyre

V_s = sliding velocity of the tyre

T_{INT} = core temperature of the tyre

4

$$TC_{RAD} = fn(F_z)fn(P_t)$$

5

$$\Delta FF_{FACT} = \frac{a_{y_cur} - a_{y_ref}}{wdf \cdot a_{y_ref}}$$

ΔFF_{FACT} = change in force factor

a_{y_cur} = measured lateral acceleration for the change

a_{y_ref} = measured lateral acceleration for the base set up

wdf = weight distribution at the front

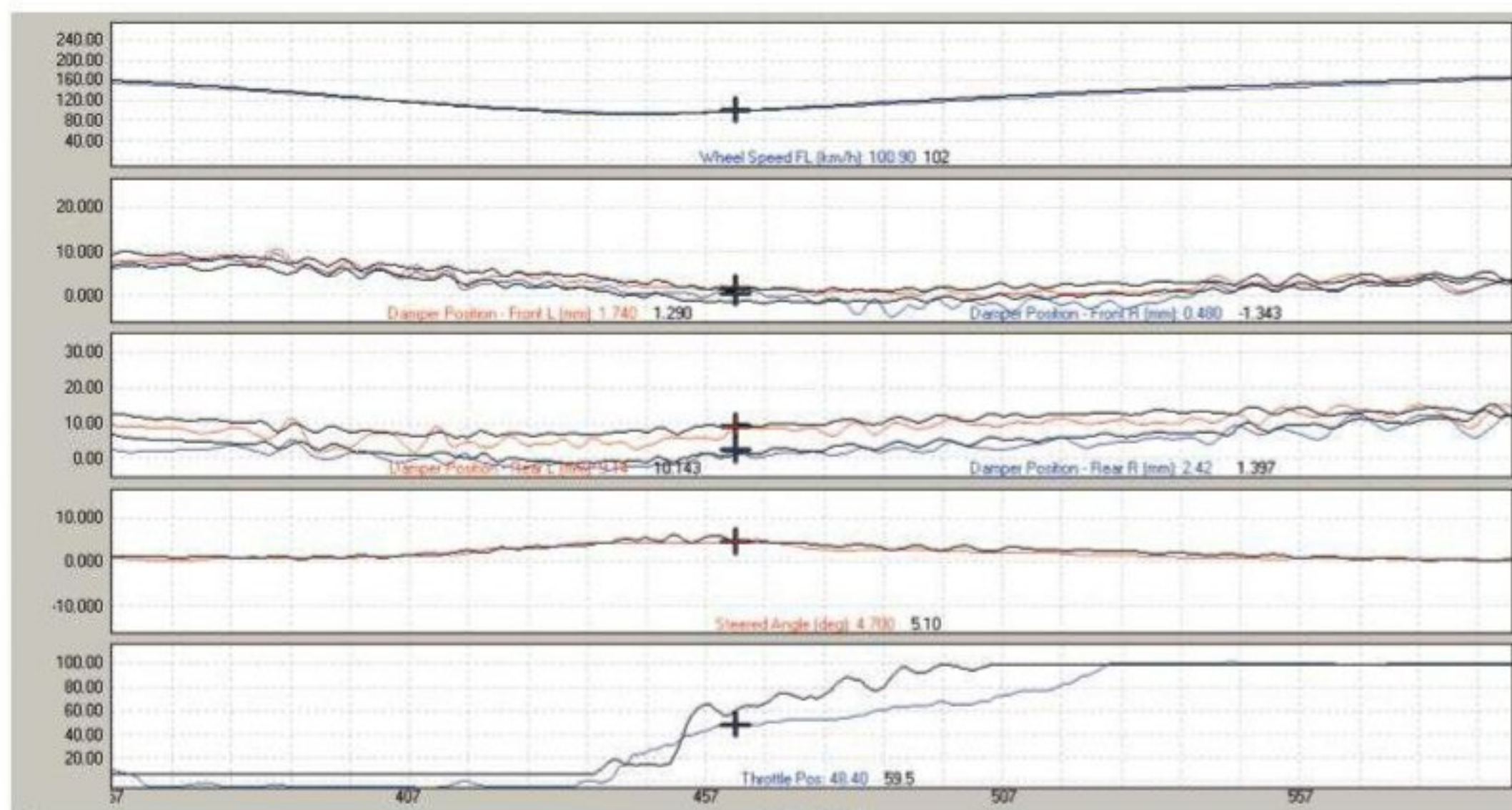


Figure 1: typical 2D tyre modelling correlation using ChassisSim

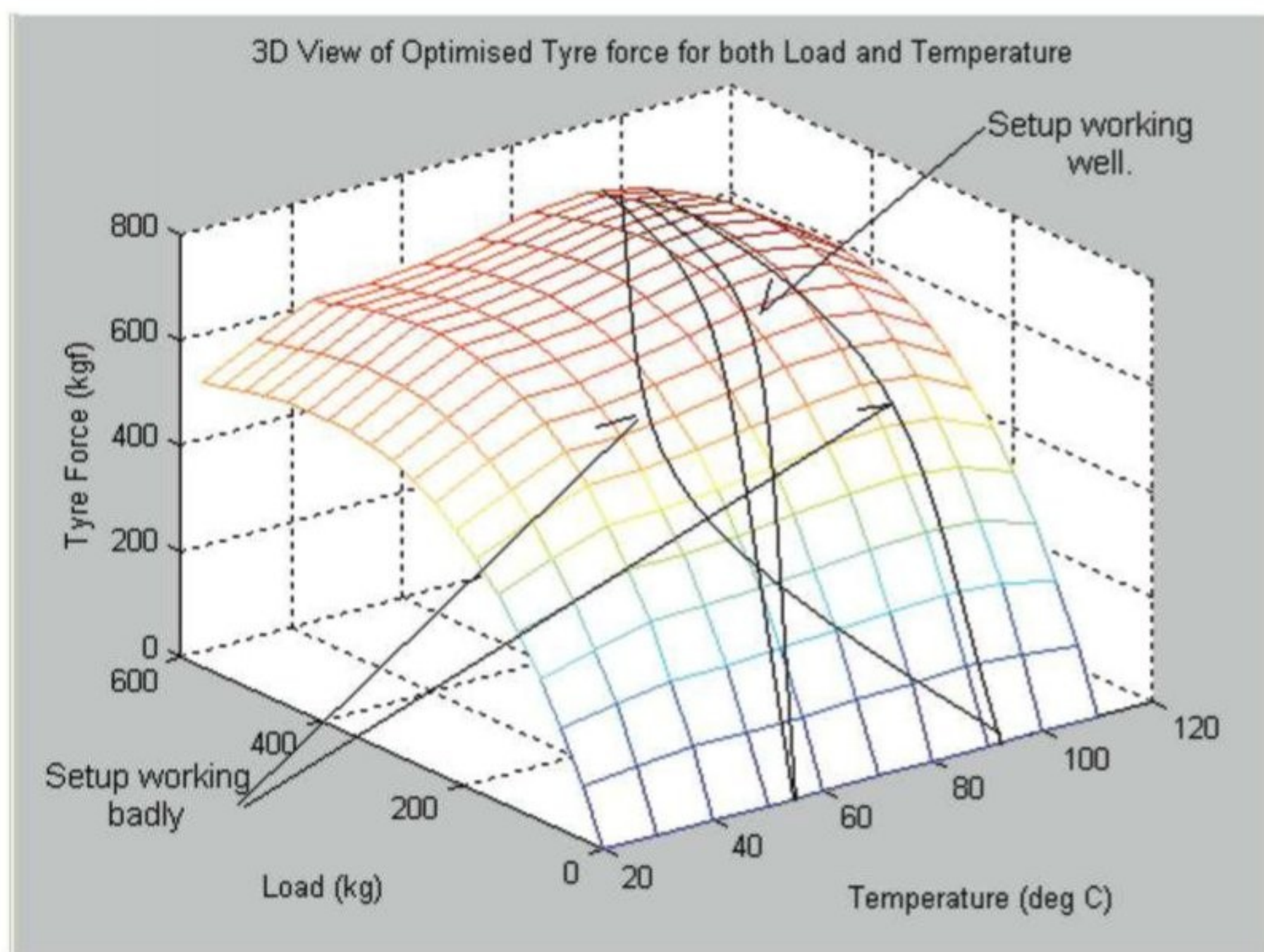


Figure 2: an illustration of what you obtain from a 2D tyre model

Table 1: typical V8 Supercar set up

Parameter	Value
Front roll centre	100mm
Rear roll centre	240mm
Front wheel rate	60N/mm
Rear wheel rate	60N/mm
Front bar wheel rate	40N/mm
Rear bar wheel rate	10N/mm
Front track / rear track	1.6m/1.6m
Front tyre spring rate	305N/mm
Rear tyre spring rate	305N/mm
c of g height	0.45m

"a 2D model gives you a good broad brush stroke, but lacks fidelity"

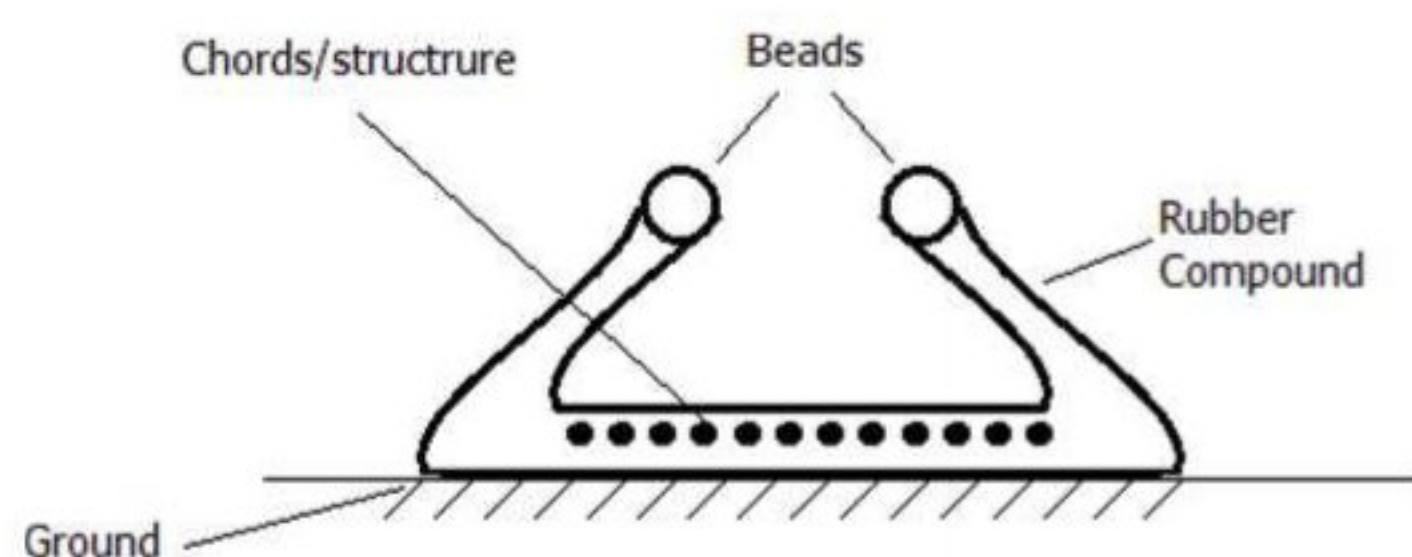


Figure 3: tyre schematic

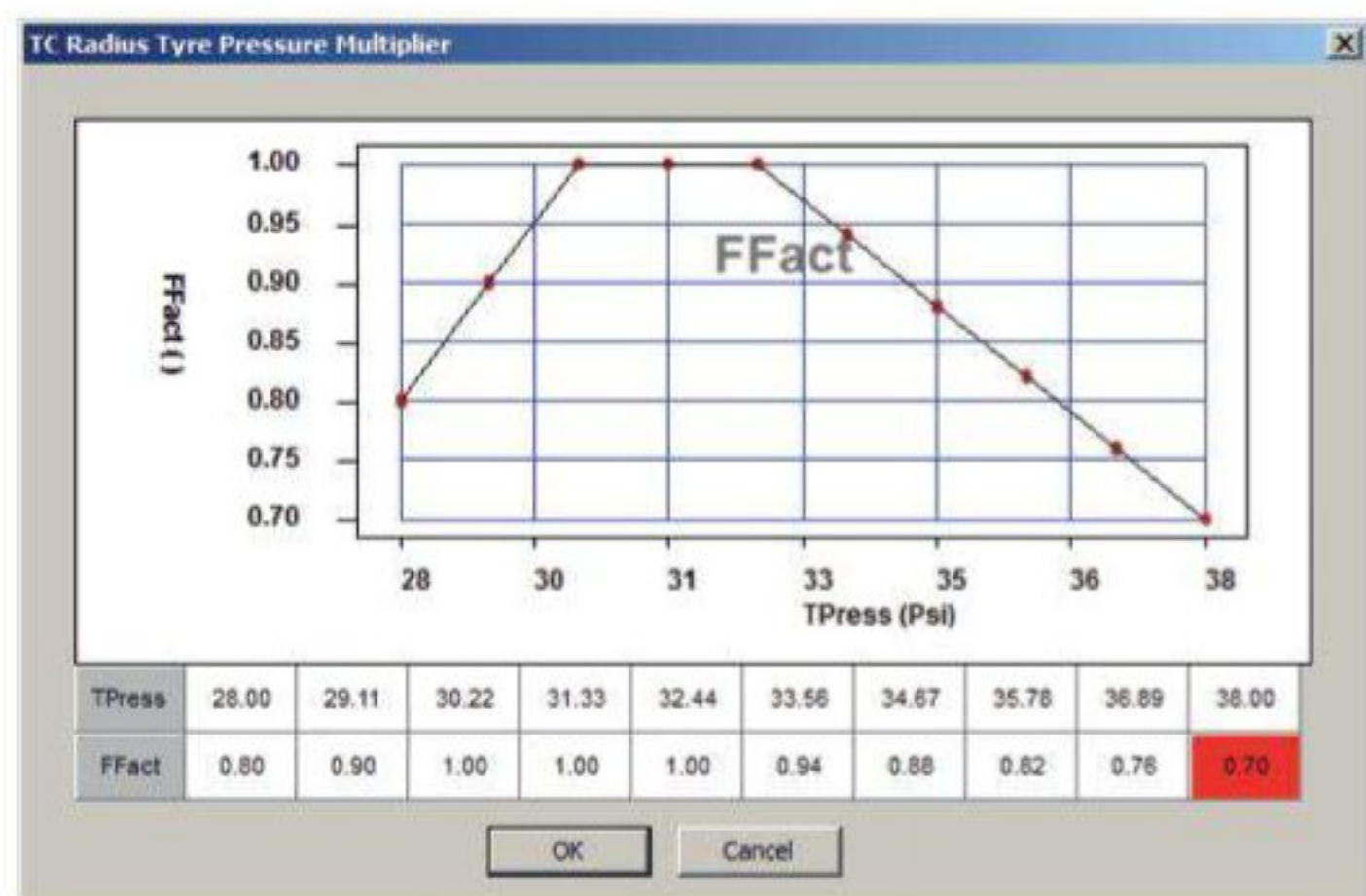


Figure 4: FFact multiplier of traction circle radius vs tyre pressure

Figure 5: set-up reference dialogue from ChassisSim

The reason the change is so small is that the delta forces produced by the 2D model are miniscule. This is primarily due to the peak load value of 850kg. When we crunch the numbers, the magnitudes of the changes are so small because the gradients of the tyre force curve are tiny. This is due to the outside tyre loads approaching the optimum tyre load of the model. Don't take my word for it, do the numbers yourself. A simple 2D tyre model is given by following equation 1.

There are a number of things you can do to mitigate this but, ultimately, it compromises

your model in other areas. For example, to go for set up sensitivity we can drop the peak load. It gives you sensitivity, but it compromises accuracy for high-speed corners and adding more downforce. Clearly, there is something else at play here.

To figure a way out of this mess, let's consider what the tyre is actually doing. We'll start with a tyre schematic, as in figure 3. What happens is, as we apply different set up conditions to the tyre, the internal temperature and the tyre pressure changes. There are a number of factors that come into play here. The first is the effect this has on

Table 2: representative 2D tyre model for a V8 Supercar

Parameter	Value
Initial coefficient of friction	2.2
Peak load	850kg

Table 3 - predictive numbers for a rear roll centre change (all loads are shown in kg, the lateral forces are shown in N and V_pred is in km/h).

Set up	Load FL	Load FR	Load RL	Load RR	FyR	V_pred
RRC 240	674.96	133.82	694.58	54.47	9993.5	81.47
RRC 250	671.61	137.16	697.93	51.1	9938	81.27

Table 4 - tests to run for set up referencing

Test no	Set up	What to record
1	base set up	tyre pressures + data
2	base set up + front TP -2psi	tyre pressures + data
3	base set up + front TP -1psi	tyre pressures + data
4	base set up + front TP +1psi	tyre pressures + data
5	base set up + front TP +2psi	tyre pressures + data
6	base set up + rear TP -2psi	tyre pressures + data
7	base set up + rear TP -1psi	tyre pressures + data
8	base set up + rear TP +1psi	tyre pressures + data
9	base set up + rear TP +2psi	tyre pressures + data

the contact patch variation (see equation 2). As we can see, as the pressure goes up, the contact patch length, and area, goes down. Consequently, there is less area for the forces to be applied and the tyre force goes down. Conversely, when the temperature and pressure is not optimal, there is more contact patch length and greater area. But the core of the tyre isn't up to temperature yet. This is where the second effect comes into play. From the research that Michelin did in constructing the Michelin TaMe Tire model, the overall friction of the tyre is given by equation 3.

This, combined with the contact pressure, will have a significant effect on the tyre forces, and this is what we are approximating with set-up referencing. So, reviewing this, let me propose a modification to the traction circle radius equation, as shown by equation 4.

What we have here is the 2D model we discussed in equation (1) multiplied by a factor that is a function of hot tyre pressure. This function will look something like figure 4.

Some of you might be a tad annoyed at this point, but let's take a moment to review things. From figure 1 we know we can achieve good correlation using a 2D model. However, when we investigate the nature of the numbers, the sensitivity needs to be improved. Furthermore, if we are not careful it can lead us up the garden path. And anybody that has spent more than five minutes with a real racecar knows how critical it is to get the tyre pressures right. So there must be something else coming into play, and all the results from the Michelin TaMe Tire model would indicate very strongly that tyre pressure plays a critical role. You also confirm this from running the car but, to quantify it, we need to run a series of tests, as shown in table 4.

Remember, it is critical for every run to record the hot tyre pressures. You'll also note I've indicated a sweep of +/-1psi but, in reality, this is going to be dictated by your running experience and what the car wants. The critical thing to pay attention to is the lateral acceleration data. Due to the

nature of this test, if there is a change it's very easy to isolate what caused it. We can also easily quantify the change. For example, if we are dealing with a front tyre pressure change, the delta FFact will look like that shown in equation 5.

Clearly, if you are measuring a change at the rear you simply

attach multipliers to that. This is the key to set-up referencing. While not perfect, it gets us into the ballpark, and that is our goal.

The most effective way to do this is to use your racecar simulator to match your expectations with what occurred with the car. Some of you think this is fudging. It isn't. What you

"Some of you think this is fudging. It isn't"

substitute the wdf with weight distribution at the rear (wdr). Once this data is calculated, figure 4 can be readily populated.

The next step is to match our set up data with the tyre model. The critical thing to note here is that the more roll centre you apply, or the stiffer you make one end of the car, or the more static tyre pressure you apply, the more the hot core temperature and pressure of the tyre will increase. These adjustments are a race engineer's primary tools when they are dialling in core tyre temps and pressures. What we are going to do here is match this to our baseline set up and then

are doing is using the racecar simulator to quantify what's going on with the car, which is another reason why I maintain it is imperative that you do your simulation work yourself.

So, to achieve this, we need to assign the base set up and the pressure multipliers. As an example, figure 5 shows the sample controls in ChassisSim.

As can be seen, the base set up is indicated in the first column. Note: the tyre pressure you enter here is the warm tyre pressure from the base set up. This is very important. The next step in the process is to assign the pressure multipliers. Some baseline

Table 5 - some rough rules of thumb for the set up sensitivity parameters

Parameter	Value
Tyre pressure	$1 * (TP_{cur} - TP_{ref}) / TP_{ref}$
Roll centre	$30-40 * (rc_{cur} - rc_{ref}) / h$
Pitch centre	$30-40 * (pc_{cur} - pc_{ref}) / h$
Spring / third spring rate	$10 * (k_{cur} - k_{ref}) / k_{ref-total}$
Bar rate	$10 * (k_{cur} - k_{ref}) / k_{ref-total}$

The variables here are as follows:

TP_{cur}	= current tyre pressure
TP_{ref}	= tyre pressure of the reference set up
rc_{cur}	= current roll centre
rc_{ref}	= roll centre of the reference set up
pc_{cur}	= current pitch centre
pc_{ref}	= pitch centre of the reference set up
h	= c of g height
k_{cur}	= current spring, third spring or bar rate
k_{ref}	= spring, third spring or bar rate of the reference set up
$k_{ref-total}$	= sum of all the spring and bar rates of the reference set up

suggestions (with numbers in psi) are illustrated in table 5.

These numbers are subject to car factors such as motion ratios and parameters. However, the key is to use these pressure multipliers to dial in some typical set up changes and dial this. Also, bear in mind that what we are presenting here is only an approximation. Before you turn your nose up in disgust, let me just remind you of some approximations that work pretty well - in most CFD analysis for aircraft, air viscosity is ignored,

but it gets you in the ballpark. And the calculation of damping ratios ignores tyre spring rate, but it's still a valuable tool.

Remember, the key here is we are using set-up referencing to quantify what's going on with the car. From that we can make the appropriate determination of set up changes. Consider it the first step toward quantifying how sensitive a set up change really is, and a valuable insight into determining how to make your racecar go faster.

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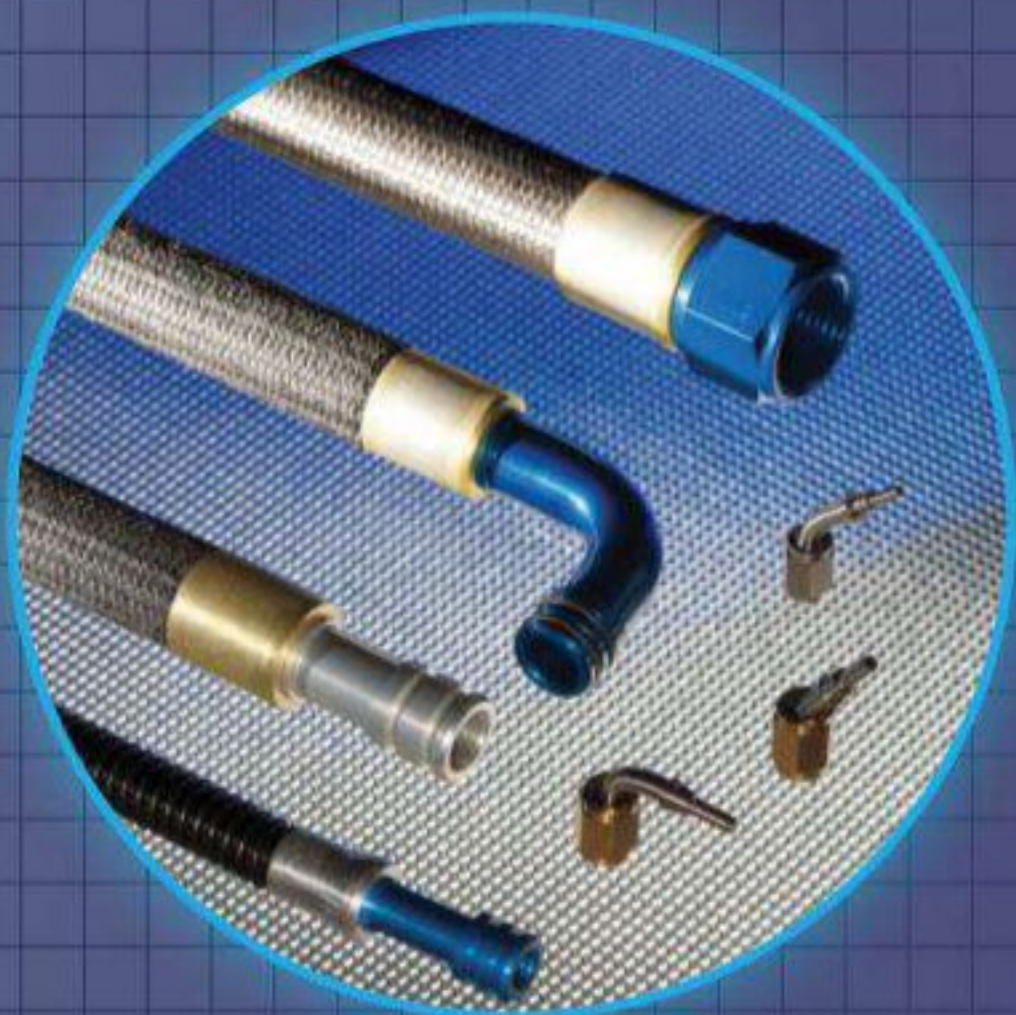


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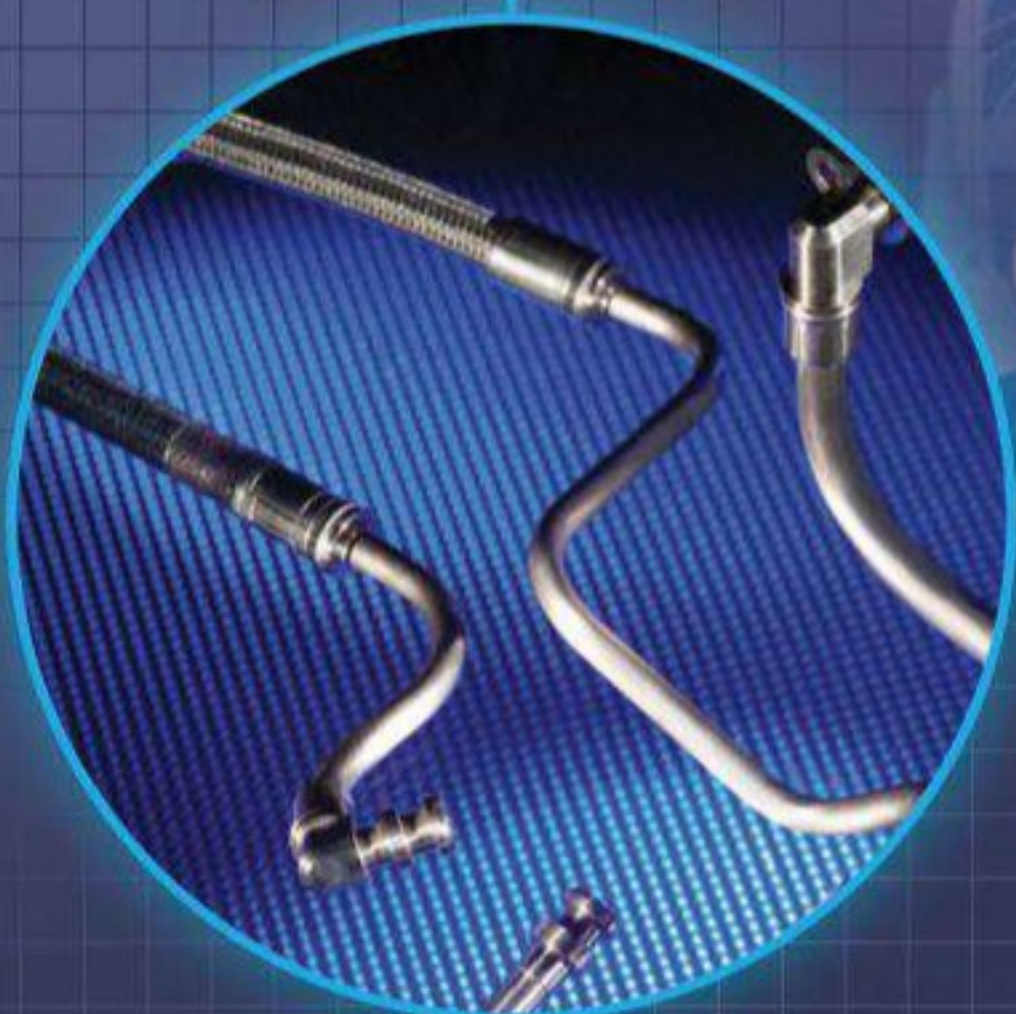
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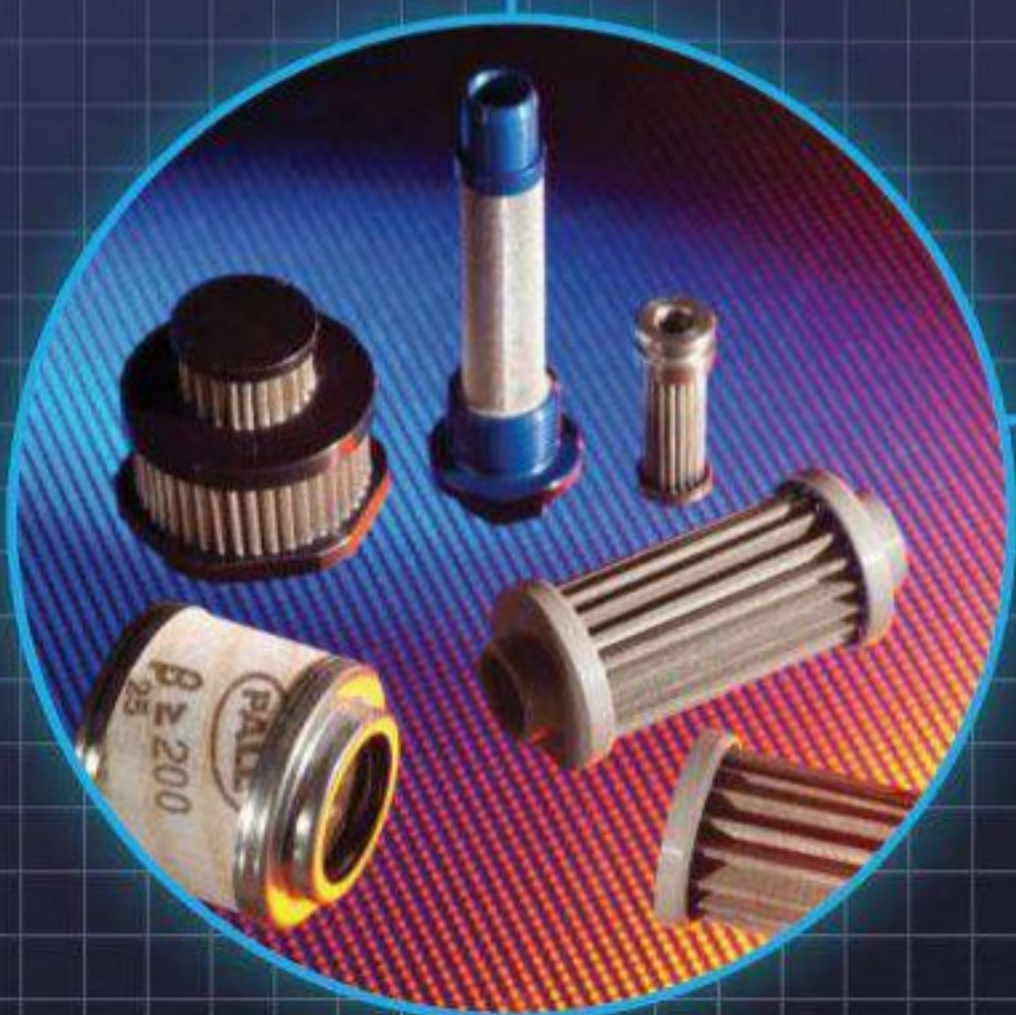
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Aerodynamics at 1000mph

If you want to break the World Land Speed Record, you now have to go supersonic. So what's involved? And what exactly is supersonic?



It's only a concept at present, but the New Zealand-based Jetblack borrows from modern fighter jet practice in its overall aero package

Understanding what air does around a racecar at 'normal' speeds is complex enough, but reaching the speed required to set a land speed record, and go on to 1000mph, involves an altered reality with different physics. Airflows become compressible, unstable shockwaves develop and move along the vehicle with changing speed, and ultimately the vehicle travels faster than the very noise it generates.

The fundamentals superficially sound simple. Clearly, any vehicle intended purely to go as fast as possible needs low aerodynamic drag, which comes from shaping and

BY SIMON MCBEATH

minimum frontal area (and, to some extent, minimum 'wetted' or external surface area). It requires stability, which means there should be no significant changes in its aerodynamic performance over the large speed regime it will encounter, and also that it is as insensitive as possible to cross winds. It will probably require neutral lift or very modest downforce to maintain more or less constant wheel loads across the large speed range. And it should have benign response to any changes of attitude, which one hopes will be minor.

As with any vehicle though, the basic requirements have to

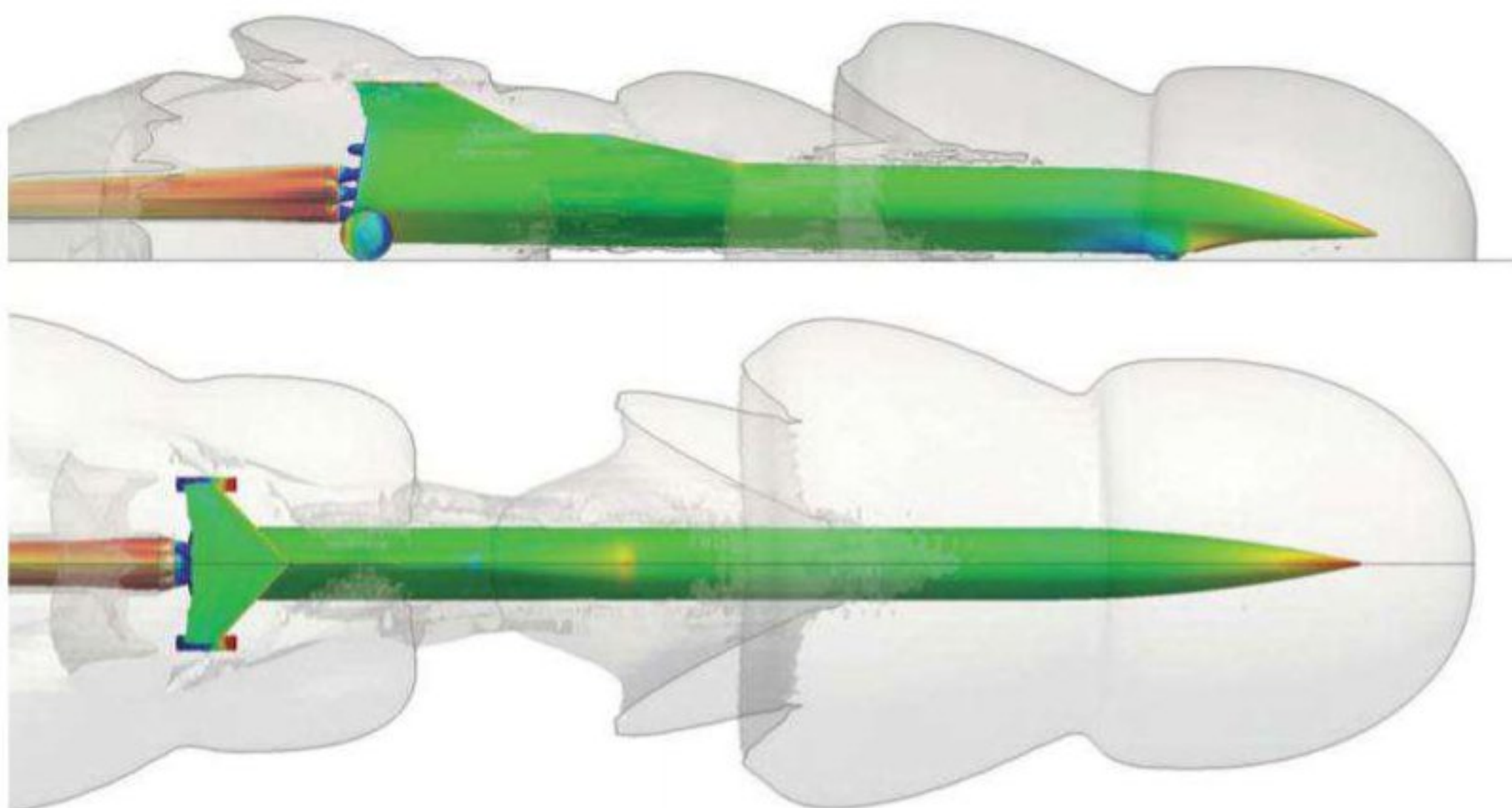
be met while also packaging the driver, the drivetrain, the wheels, the suspension and the control systems. And then there are the special requirements involved in passing through the transonic region and into the supersonic speed regime. And these requirements have direct influence on the fundamental shaping of the vehicle.

TRANSONIC AERODYNAMICS

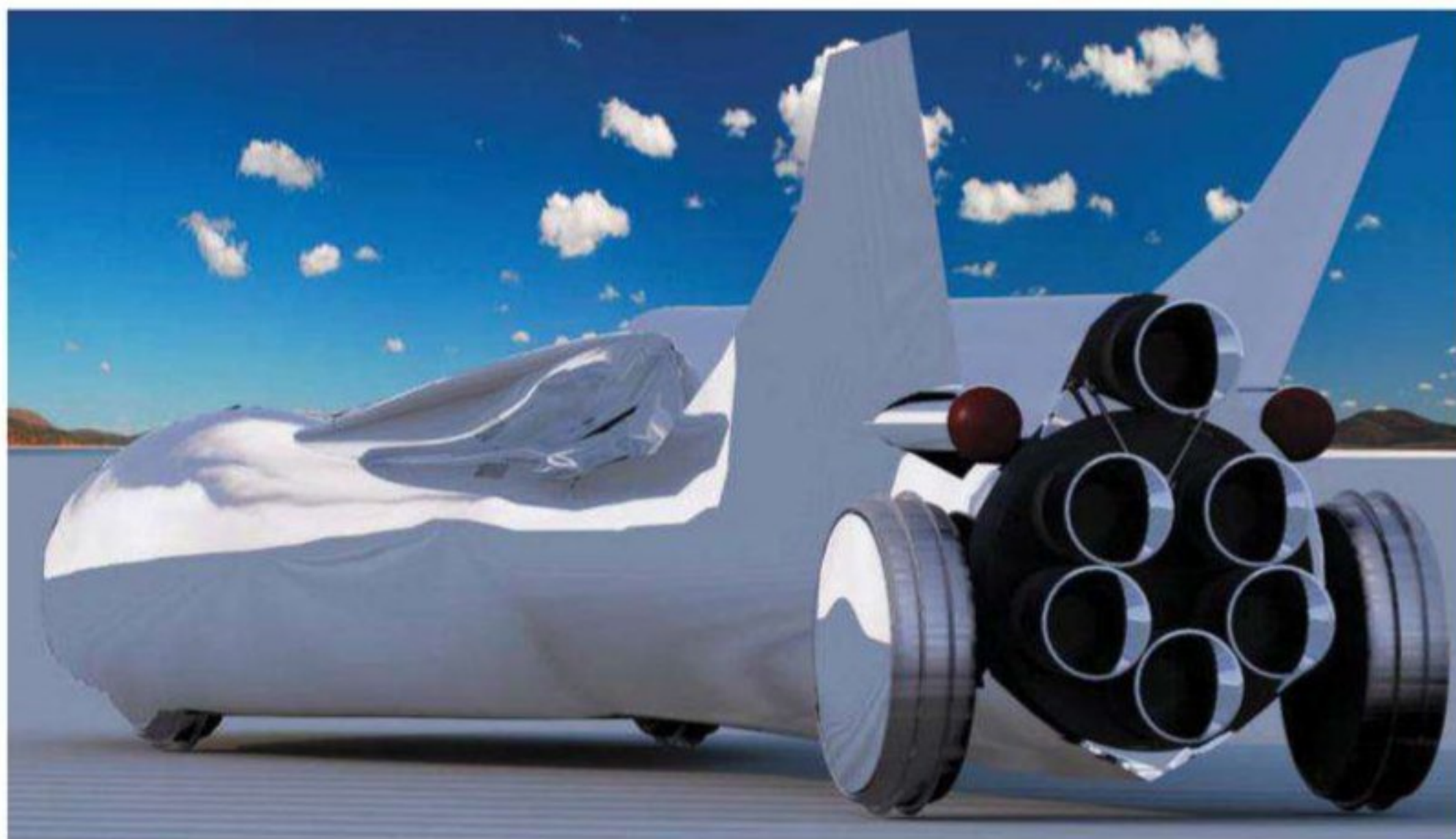
The speed regime is said to be transonic when the airflow over some parts of the vehicle accelerates to supersonic speed, while over others it is sonic or subsonic. While with aircraft the transonic speed range is typically Mach 0.8 to 1.2 (roughly

600-900mph), with ground vehicles the range is likely to be somewhat bigger because of the necessarily smaller details like wheel support struts and the wheels themselves, around which the air will locally accelerate significantly.

Where the airflow reaches sonic speeds, shock waves form. These contain a lot of energy and generate significant additional drag - up to four times subsonic drag in magnitude, and known as 'wave drag'. As the vehicle climbs through the transonic speed regime, shock waves will first be generated around the smaller detail areas, then increase until the airflow is sonic or supersonic over most of the



Shock waves occur as parts of the car reach supersonic speeds - not necessarily all at the same time. They cannot be avoided, but a great deal of work is put into minimising them, and managing their effects. All the planning and simulation in the world cannot predict every eventuality though, at 1000mph this is uncharted territory



Silver Bullet RV1 features a distinctive 'wasp waist' in an obvious application of the Whitcomb Area Rule. Twin tail fins are designed to aid yaw stability at speed by ensuring the centre of pressure is behind the centre of gravity

vehicle. The transonic region is therefore where additional power becomes necessary to overcome the wave drag. But because of the way in which shock waves initiate on different parts of the vehicle, and the way the shock waves themselves move as speed increases, it is also where aerodynamic instabilities occur.

The idea is therefore to use aerodynamic techniques to try and prevent additional shock waves forming along a supersonic body, and this is where lessons learnt in other areas of technology come into play. Shapes such as the transonic minimum drag 'Sears Haack body' (see figure 1), and nosecone

variants based on high velocity bullet shapes, such as the 'von Karman ogive' and the 'Power Series' (especially x1/2 power). Also, the application of the 'Whitcomb Area Rule', also known as the Transonic Area Rule, or

just the Area Rule. 'Fineness', or length-to-diameter ratio is also a key weapon in the supersonic aerodynamics armoury, larger ratios reducing wave drag.

A shape like the Sears Haack body, for example, with its cylindrical section, pointed ends

and very gradually changing cross sectional area would not generate any additional shock waves along the length of the body, but is not a practical shape for a ground vehicle of this type. But the general principle

"an altered reality with different physics"

of making very gradual, gentle changes to the cross sectional area still applies in reducing the number of locations from where additional shock waves might propagate, even though the final shape will necessarily involve compromises.



Minimising frontal area is crucial but, as in the case of Sonic Wind, packaging of the driver, engine and fuel tanks dictate how small this can be

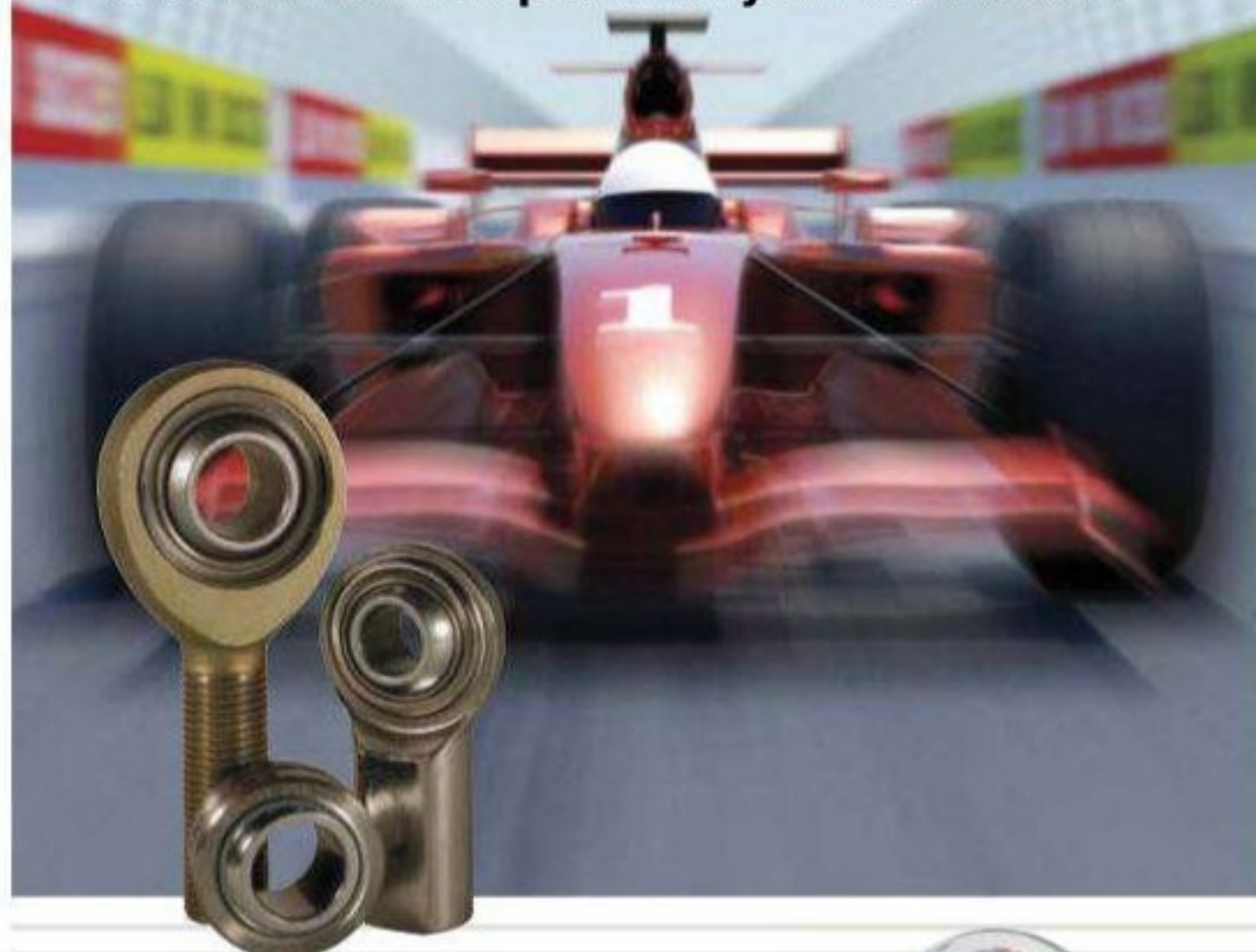


Canard wings are used to trim the vehicle and maintain balance

But it is not just from where shape changes occur that shock waves might emanate, they can also originate where there are changes in cross-sectional area, and this is where the Whitcomb Area Rule comes into play. Essentially, this states that if a shape is designed to have the same cross-sectional area distribution along its longitudinal axis, as the Sears Haack body, it will generate similar wave drag, largely independent of its actual shape. So where the packaging of internal components requires bulges or other shape changes, if the body is thinned elsewhere around that part so that the cross-sectional area is

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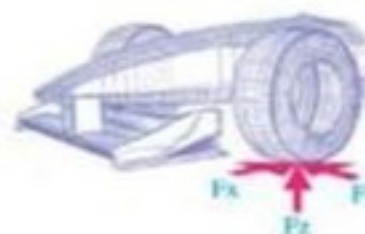
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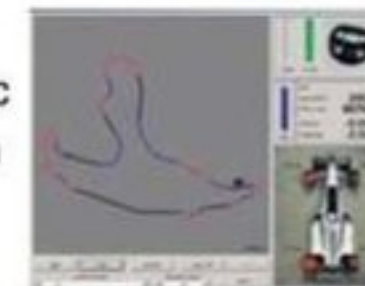
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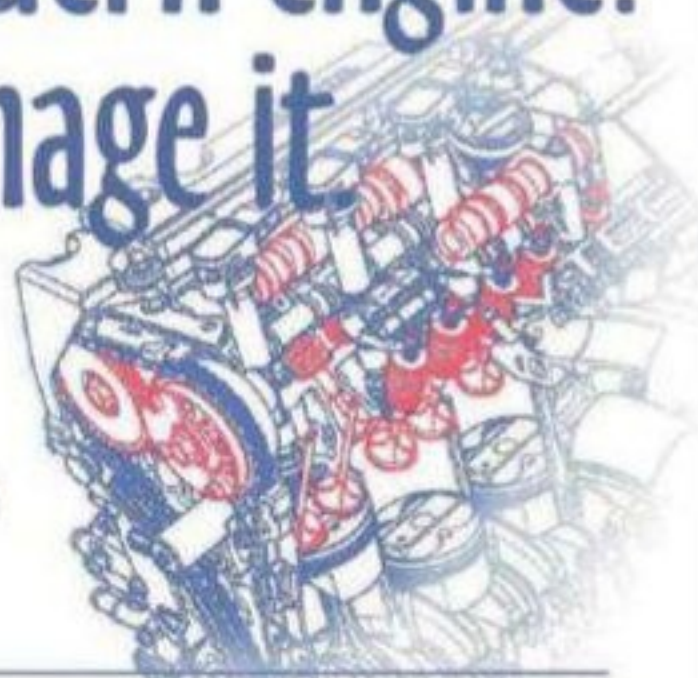
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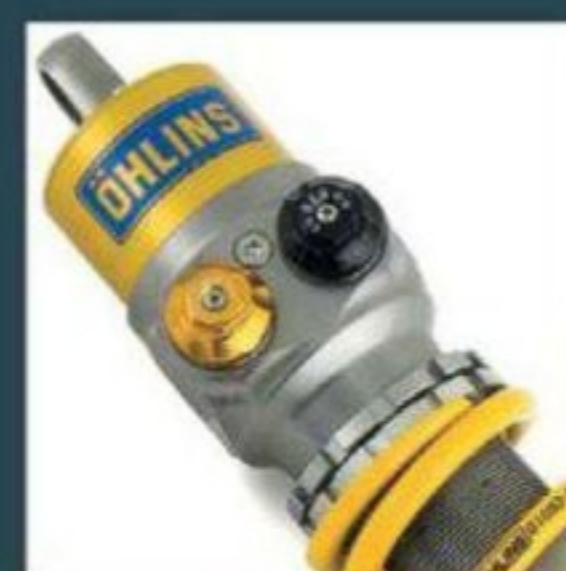
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the same as if it were circular, then additional shock formation and wave drag will hopefully be avoided. Conversely, if the shape is thinned at some point then it may be necessary to add cross section elsewhere locally so a satisfactory longitudinal distribution of cross-sectional area is maintained.

These principles have been applied in supersonic aeronautics for a long time, but land speed record vehicles differ from aircraft designs in three key ways – they have no large lifting surfaces (although trim devices might generate some lift), they run on wheels and, of course, they also run on the ground.

GROUND EFFECT

Ground proximity is put to good use on conventional racecars by accelerating air between the body and the ground, and the resulting low pressure can be managed to generate a substantial portion of a racecar's total downforce. In the context of land speed record vehicles, not only is substantial downforce unnecessary, likely causing an unwanted increase in rolling resistance, the very fact that there is a small gap beneath the vehicle can cause other

passing beneath the vehicle have exerted sufficient lift to raise the rear wheels off the ground. Thrust SSC dynamically adjusted the vehicle's pitch angle to try to maintain reasonably consistent wheel loads at these speeds, and most of the current designs carry design features and / or controls, such as active canard wings, to trim the vehicle and maintain a consistent balance.

And then there's the influence of the vehicle on the ground itself. Thrust SSC encountered a totally unexpected problem when it approached Mach 1 and the bow shock wave 'fluidised' the desert surface, generating greatly increased rolling resistance (and wheel tracks that disappeared beneath the surface by 150mm). The challenges then are considerable, so let's look to see what each of the teams is doing aerodynamically to combat these.

Aussie Invader 5R

The basic shape of the rocket only-powered AI 5R reflects the thinking of the team's well known co-designer and consultant engineer, Englishman John Ackroyd of Thrust 2 and SSC fame. 'The transonic and shock wave effects may be

" length-to-diameter ratio is also a key weapon "

unwanted aerodynamic effects.

Even in the subsonic speed region, ignoring compressibility effects, airflow entering this gap is liable to be accelerated and create reduced pressures, so ground clearance and pitch angle are even more important. And, as such, nose height and shape are critical, since this affects how much air passes under the vehicle. As Bloodhound SSC's chief of aerodynamics, Ron Ayers, explains in 'Bloodhound TV episode 5' one aspect to be avoided is the positive pressure that might occur in the convergence zone under a raised nose. Lowering the nose and using a modified nose shape can overcome this.

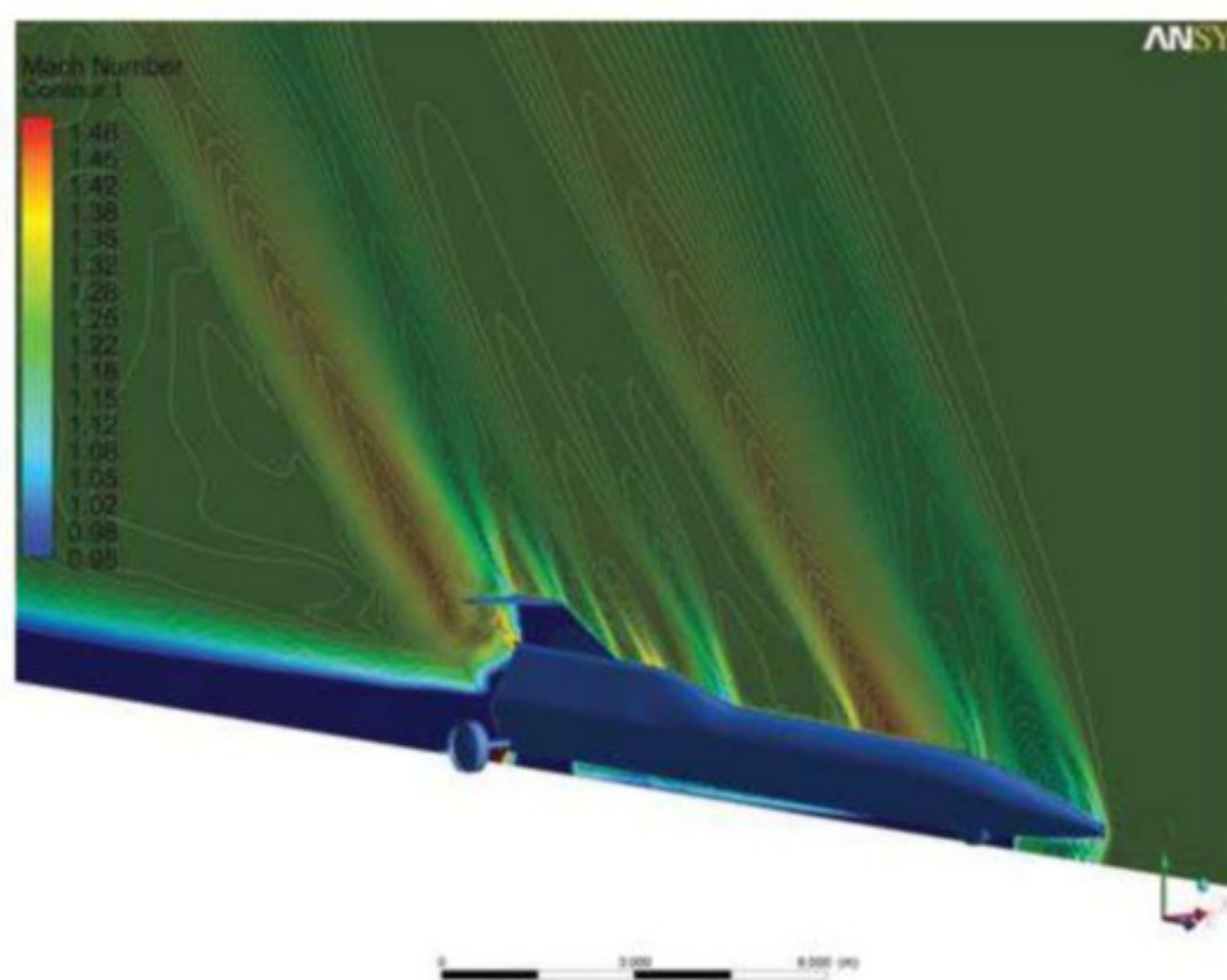
Historically, there have also been problems in the transonic region where shock waves

reduced by a slender fuselage producing a small cross-sectional area, a 'v' profile underbelly for shock deflection, a high ground clearance to achieve reduced [underbody] pressure and a rear wheel strut / support design producing zero to minimal lift.'

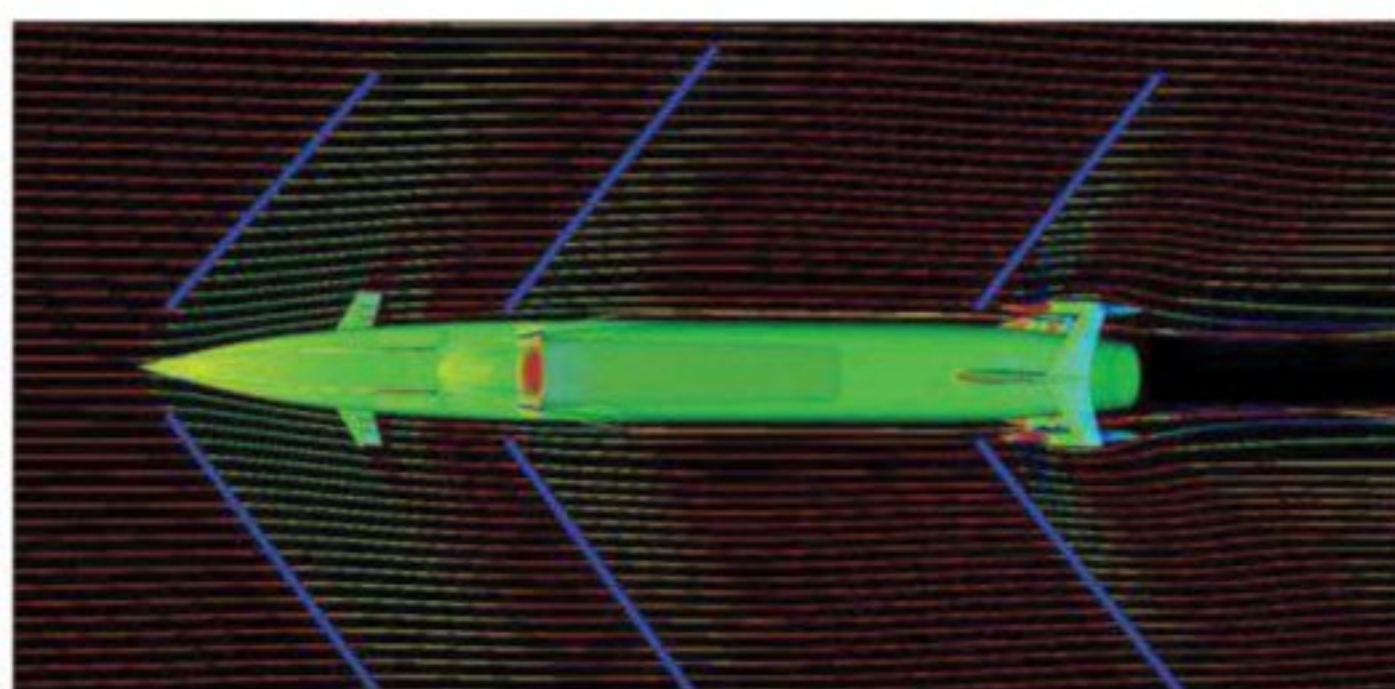
Team principal and driver, Rosco McGlashan OAM, is unequivocal about the aerodynamics of his charge: 'Aussie Invader is the most aerodynamically efficient shape ever conceived for a car. We have a single five-inch axle that, when compared with any other outrigger car, is very slick. Most run four or five two-inch round struts to locate the rear wheels – in other words, twice the area and a lot more drag. Our rear axle will have a leading and trailing fairing with a minimum amount of width



Figure 1: the Sears Haack concept, with its gradual and uniformly changing cross-sectional area, would not create additional shockwaves along its body



Supersonic aeronautical engineering is an obvious source of data at speeds approaching 1000mph but, though some principles can be applied, they are fundamentally different beasts to land speed record vehicles



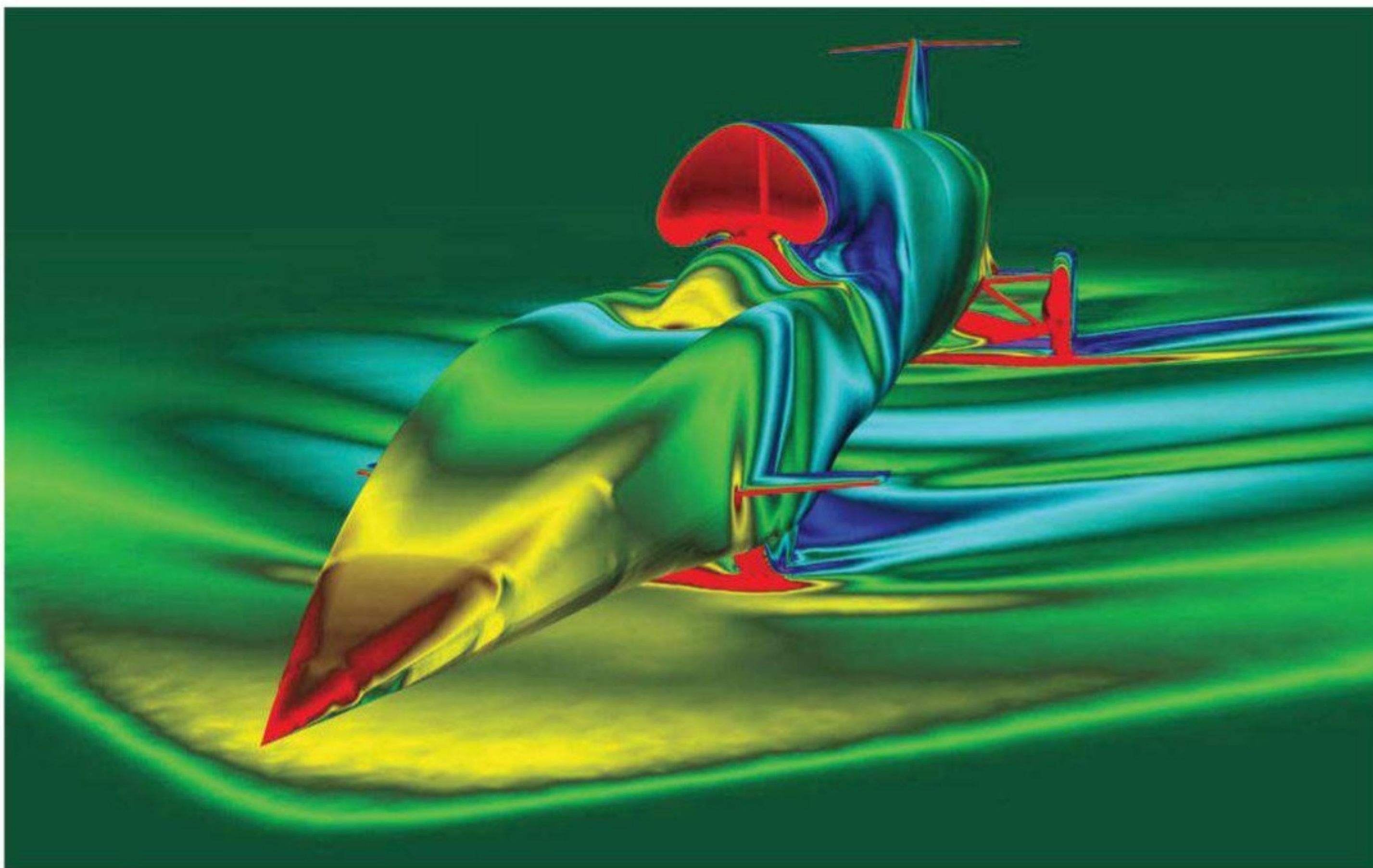
Shock waves occur where there are changes in cross-sectional area. Wave drag, which occurs as a result of this is a major obstacle at supersonic speeds

to prevent ground-generated pressure from creating lift. Rear wheel fairings are presently being investigated.'

Aussie Invader's v-shaped belly is based on minimising the effect of the shock waves on the underside, allowing it to reflect off the ground and dissipate past and around the fuselage without causing unwanted lift. An extensive CFD programme has been undertaken at Western Australia's new

Pawsey Centre, from where Dr James Jewkes of the Curtin University Fluid Dynamic Research Group commented: 'We are using the well-regarded OpenFOAM CFD library, and our methodology reflects that used by any modern motorsport team, using a validated (and sanity checked!) baseline, then gradual modifications to the design compared with the original baseline data. Our design goal is primarily to look at how we can

AERO AT 1000mph



There is much debate amongst the teams about high-mounted engine air intakes. Some say it causes lift, but the Bloodhound SSC team see it as a benefit to be exploited, utilising the fact it compresses the incoming air being drawn into the engine in much the same way as a supercharger

shave some drag off the car, and increase our understanding of the more complicated regions of the flow field. That said, as any good CFD engineer will tell you, it's very difficult to exactly match the numbers that one would encounter in reality... but we believe the deltas will match, and any improvements seen in our simulations will be reflected in the real world. More importantly, potentially dangerous shock wave interactions can also be better understood.'

Bloodhound SSC

Unlike AI 5R, Bloodhound is both jet and rocket-powered, and has a wider fuselage, reflecting a wider front track dimension. It is also considerably taller because of the high-mounted jet engine and its large intake.

The project's chief of aerodynamics, Ron Ayers: 'The secret of designing a trans / supersonic vehicle is to make it as slender as possible and minimise the severity of section changes down the length. In this way you greatly reduce the number and size of shockwaves. The flow under the car should

also be reasonably well behaved, as the underside is parallel and featureless - apart from the wheels... and the v-section creates less blockage.'

Alluding to the large jet engine intake duct, Ayers continued: 'Intakes have the job of collecting air for the engine and, in doing this, they are going to create drag. However, this is the wrong way to look at it. The intake pre-compresses the air before the engine's axial compressor compresses it further still. When heated by combustion, this is what creates the thrust. So the intake, and its drag, is an essential part of the engine! Think of it as acting like a supercharger...'

In relation to the effect of shock waves fluidising the running surface, Ayers remarked, 'I used the CFD to check that the pressures on the desert surface are greatly reduced [compared to Thrust SSC]. Experience will show whether I have done enough to prevent the desert from being churned up.' And in relation to 'spray drag', wherein salt and / or dust kicked up by the front wheels becomes entrained with

the vehicle at speed, adding significantly to mass and drag, he continued, 'On Bloodhound SSC the rear suspension is not in the firing line of the spray. Also, the reduced shock waves should reduce spray. We will see!'

Silver Bullet RV1

Silver Bullet RV1, the Bullet Project's supersonic contender again features rocket power only, but has a wider front track still, and accordingly a rather different body shape. There is a distinctive 'wasp waist' aft of the front wheel fairing, a very obvious application of the Whitcomb Area Rule, as confirmed by joint project principal, Paul Noone: 'In the case of the Silver Bullet RV1, the narrowing of the fuselage behind the front wheels avoids the stack up in cross-sectional area that would otherwise have occurred where the cockpit and canard wings are located. One of the principal aerodynamic challenges is wave drag, and by keeping the cross-sectional area as small as possible and avoiding big jumps in cross section, this can be minimised. However, this has to be balanced against

compromising the dynamic stability of the car. We believe a conventional four-wheel layout is still the best platform. And twin tail fins make a car less sensitive to crosswinds than a single large tail fin.'

The twin tail fins are essentially employed to aid yaw stability by ensuring the centre of pressure is aft of the c of g, which has been located as far forwards as possible. Various methods of generating downforce are also being considered, including nose shape, hydraulically-adjustable, disc-shaped canard fins and ground effect tunnels under the nose. The channel between the tail fins is also intended to increase downforce at speeds over Mach 1 by using 'compression lift', wherein air is forced against the steeply dihedral fins by the bulge created by the rocket propellant housing.

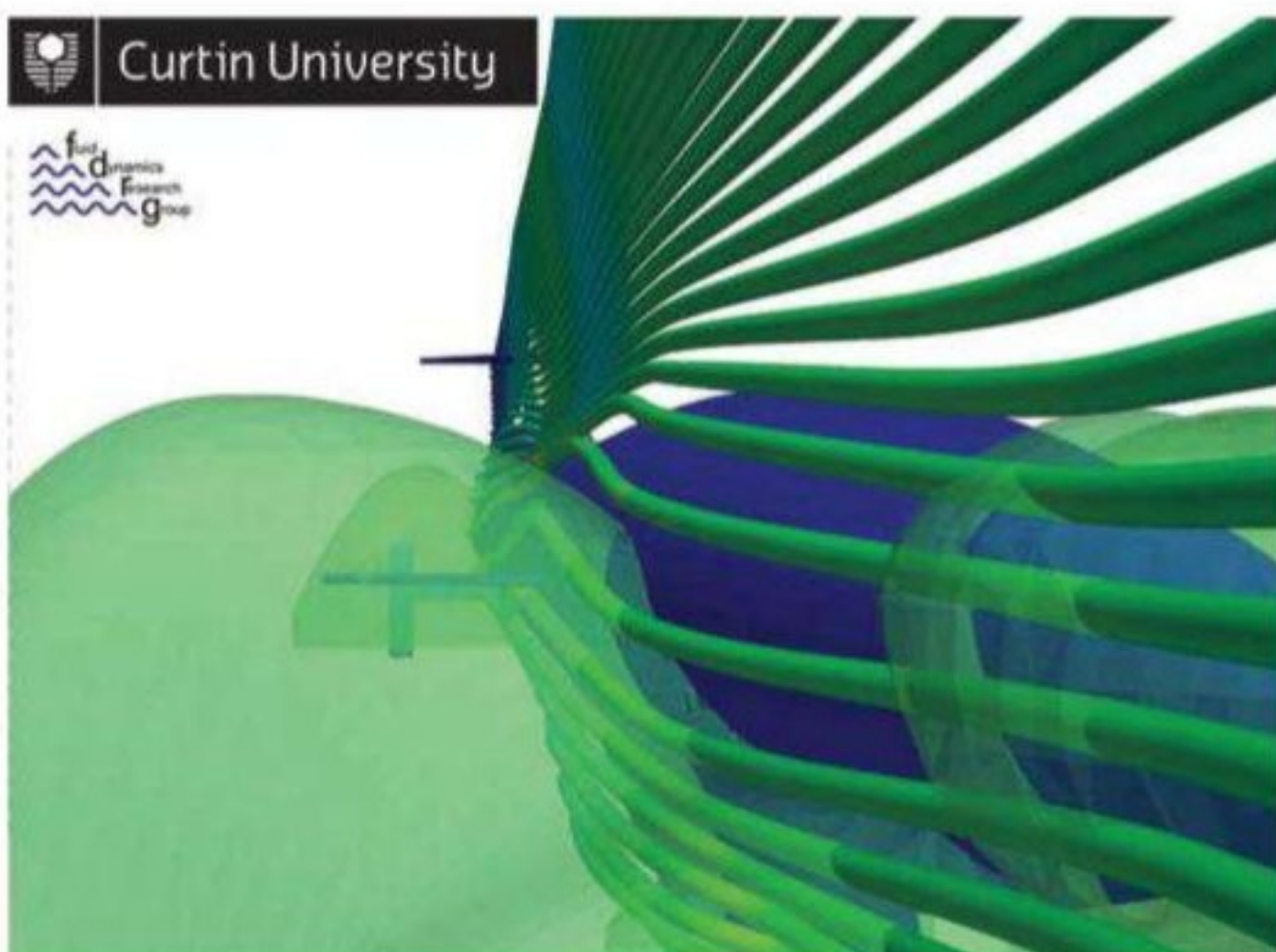
Intriguingly, Noone also stated that 'spray drag' would hopefully be avoided by Bullet's front track being wider than the rest of the fuselage. He did, however, add this cautionary note: 'If experience shows otherwise



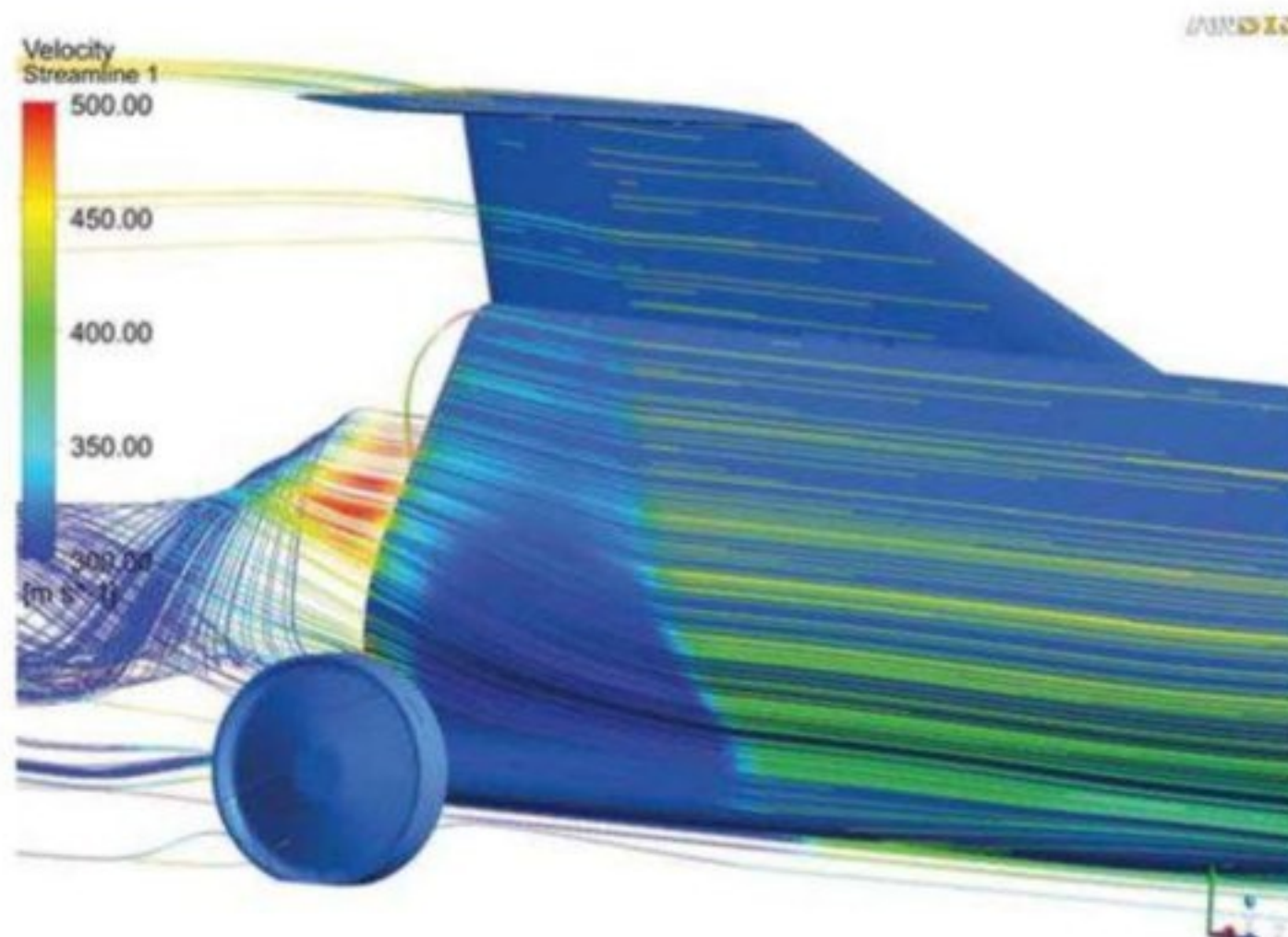
Aussie Invader has a small frontal area and a narrow lower fuselage, designed to deflect shock waves away from the vehicle



Sonic Wind has been designed purely around packaging the driver, engine and fuel tanks, the latter defining the frontal area of the car



In computational form, the shockwaves running over the fuselage of the Aussie Invader are highlighted ahead of the build programme



The rear axle of the AI 5R has a leading and trailing fairing with a minimum amount of width to prevent ground-generated pressure from creating lift

we can add tunnels, as was done on the JCB Dieselmax, to aerodynamically divert any spray.'

CFD development continues and the shape will evolve to meet the requirements of achieving the 1000mph target speed while, as the team behind it put it, 'keeping Silver Bullet under complete control.'

Jetblack

The New Zealand contender, Jetblack, whose target is simply to break the current outright World Land Speed Record, is akin to Bloodhound in utilising both jet and rocket power but, after that, any resemblance ceases. Indeed, Jetblack's conceptual shape is unlike any of the other vehicles embarking on the land speed record endeavour, but at this relatively early stage perhaps the images we are seeing now should not be regarded as definitive.

The layout features a relatively wide front track, with

all four wheels enveloped in curvaceous extensions of the main body. But most distinctive of all, Jetblack features a body that widens towards the base, with a sharp lower edge and a flat looking underside.

The team's aerodynamicist, Richard Roake, explains: 'Our approach is to minimise the number of shocks and, after that, to make them as weak as possible. Most recently designed

fighter aircraft incorporate some of this, so it's not exactly new technology. Shocks do occur under the car, I doubt you can completely get rid of them and I don't see an advantage in doing so. Yaw sensitivity currently looks low, but it's an area we haven't

done much work on yet.'

Jetblack is now using software from project partner, XFLOW, for its CFD analysis. This uses a particle based rather than a mesh-based code, and this is proving especially useful in this context. Roake: 'We have a model that accounts for dust and salt entrainment. It's a significant part of the drag, probably in the range 11-12 per cent of the total drag at design speed.' Team founder

It's clear then that CFD is playing a large role in Jetblack's early development but, as Richard Roake neatly put it, 'We will then go on to discover with actual runs what it is that we don't know, and hopefully fix as we go forward.'

North American Eagle

The sole jet engine-only challenger, North American Eagle (NAE), differs from the other contenders in one other important respect - it has already made some meaningful runs. Based on a Lockheed F104 Starfighter airframe, essentially with wings removed and wheels added, including an extra set mid-fuselage, it has clearly been shaped to travel supersonic, so the challenge for this project is to ensure it can safely do the same while running on the ground.

Team co-owner and driver, Ed Shadle: 'We will have a great deal less pressure build up under our vehicle than Thrust SSC because

"the transonic speed range is typically Mach 0.8 to 1.2 (roughly 600-900mph)"

and project director, Richard Nowland added, 'Our partnership with XFLOW not only enables full-body aerodynamics, but we can also simulate some of the effects the spray has, and that's vital for us in understanding as much as we can about our vehicle.'

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The North American Eagle features a rounded, aeronautical fuselage under the car to allow shockwaves to travel off at oblique angles

it had a large, flat underside, whereas the NAE has a rounded underside. Even Ron Ayers told me the rounded bottom would make it much easier for the shock waves to travel off at oblique angles. The rear of the vehicle will have the greatest propensity for lift, and will require some special engineering tricks to keep that part planted on the ground.'

Alluding to the salt spray phenomenon, Shadle added, 'We expect some drag development along the fuselage but it is much more severe on salt than it is on dirt. The salt clings to anything it hits and builds up on the surface.'

Aerodynamic trimming will be done with adjustable front canard fins. The nose canards are 18in

(457mm) long and built in the same aerodynamic shape as the F-104 wing. The team currently runs them parallel to the ground plane but they are adjustable. Shadle: 'As our CFD analysis is validated against physical runs at higher speeds, we will change the angle as a factor of speed. The angle can be changed based on input from the onboard data acquisition system.'

The team is relying a great deal on computational fluid dynamics because, Shadle says, 'It is so accurate, and it is easy to model various situations and then run the solutions in CFD. We will conduct [physical] runs with a lot of strain gauges, load cells, accelerometers and pressure sensors located in

strategic locations to validate the computer analysis.'

Sonic Wind

Probably the smallest of the current contenders, Sonic Wind is rocket-only powered and has been sized purely to fit the driver, the motor and the 30in (762mm) diameter fuel tanks, the latter being the defining factor on the frontal area of the fuselage.

Front and rear wheel tracks are narrow, and part of designer and driver, Waldo Stakes', design philosophy is that the aerodynamics will provide the vehicle's stability. 'The key to building an LSR vehicle is to build a "supersonically stable" vehicle from the start, and then accelerate it as fast as possible into the speed regime where it will become most stable. Then it is simply a question of balancing the vehicle's weight against the lift and drag forces in order to achieve the speeds desired.'

'I have shaped the entire fuselage into a 'bell' shape [cross section] and air is denied access to the underside of the vehicle as much as possible. Any air that tumbles past the front wheels is tripped by a vertical von Karman supersonic ogive air dam with a blunt back end. This flow is then controlled by a tunnel under

the centreline of the car and vacuumed out the back by the rocket plume.

'I have used a cruciform tail to keep the rear end stable, this form of tail resisting movement better than any other design. And I also use twin canted out 'bi-wedge' design tails below the vehicle's c of g. These generate shock waves that strike the ground on either side of the rear of the vehicle, and the pressure created by them holds the vehicle in roll. Most designers would use a widespread pair of wheels at the rear to do that job, but those wheels will generate shock waves that will choke off airflow under the rear of the vehicle and create rear lift.'

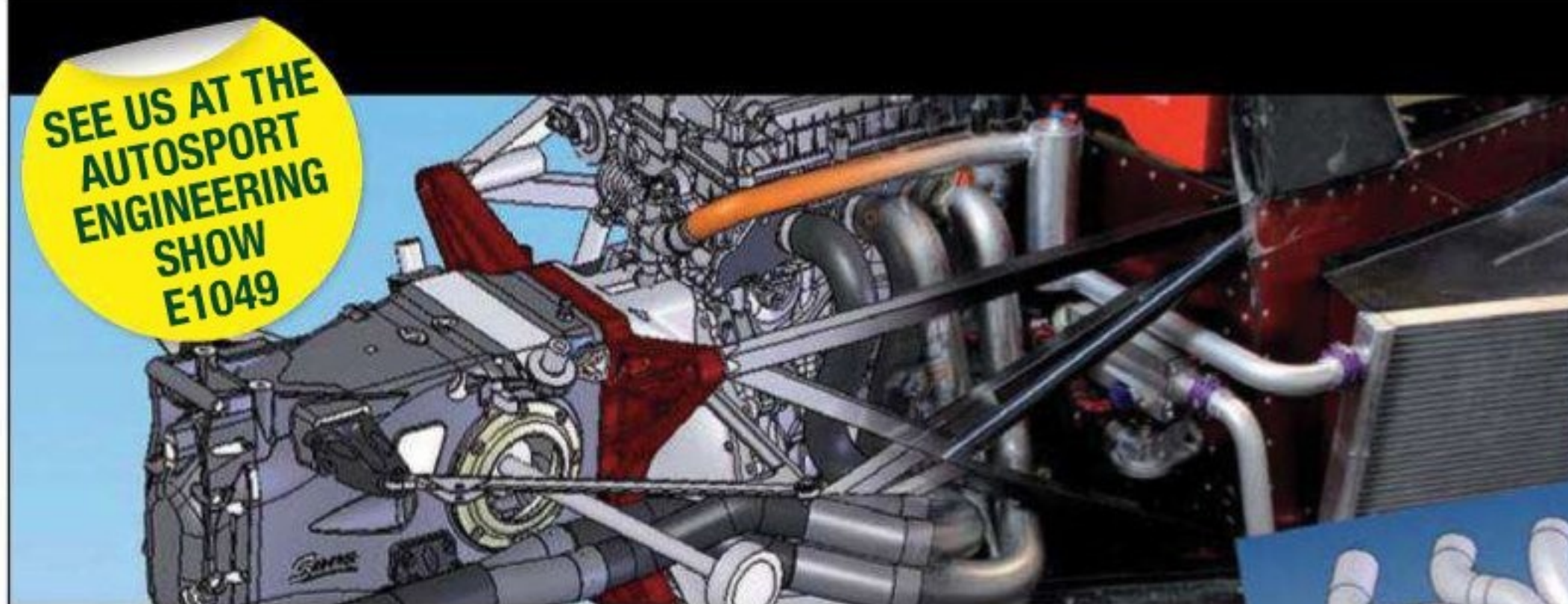
Sonic Wind has been shaped with the aid of CFD, but Stakes is more reserved about their value to the finished design: 'CFD will give your ideas validity and corroborate your concepts, but then [you need to] build a metal model and ground plane fly it in a supersonic wind tunnel. Then you won't be guessing, you'll know without a doubt.'

So it remains to be seen who will get there first, and whether we might then see the record changing hands soon after. It's all going to be about risk management...



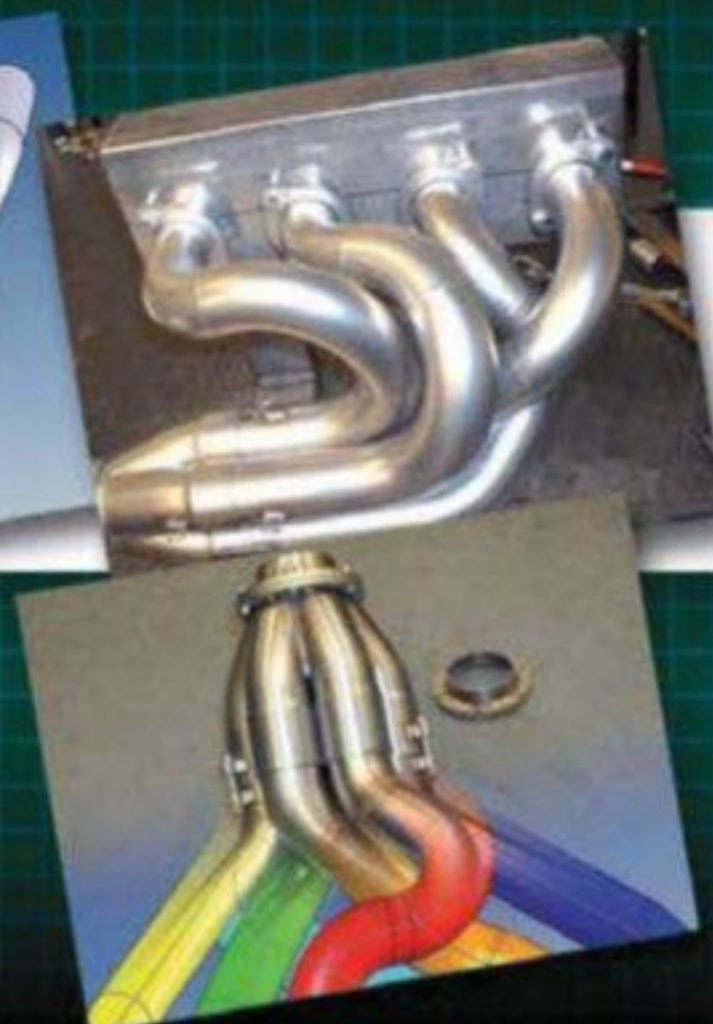
Steve Fossett's car has been rebuilt and re-wired from the ground up, with a longer wheelbase, wider track and lengthened wheel covers

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No cheap solution

An investigation into the effect of the ACO's 2009 rear wing regulations

BY MIKE FULLER

In 2009, the ACO introduced new rear wing regulations in response to a spate of frightening, yaw-induced blow overs that seemed to increase in frequency during the 2008 season. At the September 2008 ACO press conference at Silverstone, the ACO's Daniel Poissenot reflected on the reasoning behind the changes. 'Safety is important, we have invested a lot in circuits, but cars are going faster and faster. This has created accidents and has concerned us. We have to reduce the speed of the cars.' Ironically, he then added, '...and reduce costs. Cars should be cheaper to build and cheaper to race.'

The rear wing changes were quite simple: a reduction in span from 2 metres to 1.6m and a shortening of wing chord from

"a desire to simply reduce cornering speeds"

300 to 250mm. The rear wing changes weren't necessarily a direct response to the yaw incidents, but were made more out of a desire to simply reduce cornering speeds in general, as that was felt to be a contributing factor to the blow overs.

The immediate effect was a loss of total downforce and a significant change in front-to-rear aerodynamic balance. Between seasons development naturally produced balanced cars, but with perhaps slightly less downforce and a little more drag. Ultimately, that was the goal of the regulation change.

And you can't argue against the results. Lap times did indeed



The rear wing changes decreed a reduction in span from 2m to 1.6m and a shortening of the wing chord from 300-250mm. No one expected it to lead to a complete re-design of the uprights as well



The reduction in rear wing span is immediately apparent in these pictures of the 2008 (top) and 2009 (bottom) Pescarolo. And while lap times did slow straight afterwards, other factors came into play at the same time, including the introduction of domed skids beneath the car that increased ride height and improved safety

slow in 2009, but analysing events that ran to full 2009 ACO regulations (Le Mans Series events, Le Mans, in addition to Sebring and Petit), qualifying lap times increased an average of two per cent. But then again, how much of that lap time increase could be attributed to the 10 per cent power reduction the diesels were given for 2009? The narrow span rear wings, coupled with the 20mm domed skids beneath the cars, introduced at the beginning of 2009 as well, did seem to have a cause / effect relationship, in as much as there haven't been any yaw-induced blow overs since. But what was more influential – the narrow rear wing or the domed skid that increased running heights significantly?

NEW TRENDS

In direct response to the changed regulations, two new trends emerged, with one driving the other. First, in order to recoup as much of the lost downforce as possible, aerodynamicists began utilising more aggressive rear wing angles of attack, in addition to more extreme wing profiles and cambers.

The second trend was in response to the first, and ultimately was more intriguing, if perhaps only initially. The intriguing bit was that, simultaneously, Audi and Acura debuted their R15 and ARX-02a

respectively, with near identical details in the area of the rear wing. Instead of utilising a conventional bottom rear wing mount, both cars arrived with top mounts for the rear wing, the so-called 'swan neck' mounts. But how could two cars with completely divergent design philosophies come to the exact same design execution in such a

"surely there were vastly less expensive alternatives?"

critical area? What was going on here, another Stepneygate?

The answer, as it turns out, was comparatively boring, and quite simple. As aerodynamicists started to go down the route of more aggressive rear wing

assemblies, they stumbled upon one fundamental problem – flow separation in the area of the conventional rear wing mounts. And apparently the solution was a pretty universal one, hence Audi designers using an Italian scale wind tunnel agreed with Acura designers using a virtual wind tunnel.

But in the end, how much downforce was really lost by the initial span and chord reduction? And how quickly was it gained back? In the winter of 2008 it was obvious that the world economy was in the gutter. Yet the ACO was proposing expensive safety changes for the following season, with the singular objective of slowing the cars down. Surely there were vastly less expensive alternatives? And how effective really were the narrow wing rules in reducing downforce? We've assumed they did as intended, but aerodynamicists are a clever lot, and it would be pretty naïve to assume they just accepted the loss.

But what methods could we use to independently explore the effects of the ACO's 2009 rear wing regulations? Could we also replicate what was seen in the development of the swan neck rear wing mounts? If the cause and effect was so universal, could they be repeated?

THE CFD OPTION

Inquiring with insiders at various LMP manufacturers produced little in the way of concrete answers. Apparently discussions of downforce lost are as short as discussions about downforce gained, even when only looking for a relative answer. This would be telling in hindsight. Short of a good sized budget and a wind tunnel, this investigation was coming to a rapid halt. But, of course, there was CFD. Could these questions be investigated accurately utilising commercially available CFD?

Tapping the talents of *Racecar Engineering's* Simon McBeath, the CFD option quickly became reality. The only thing required was the time to generate the CAD files on my end, and all the meshing and case running on Simon's end.





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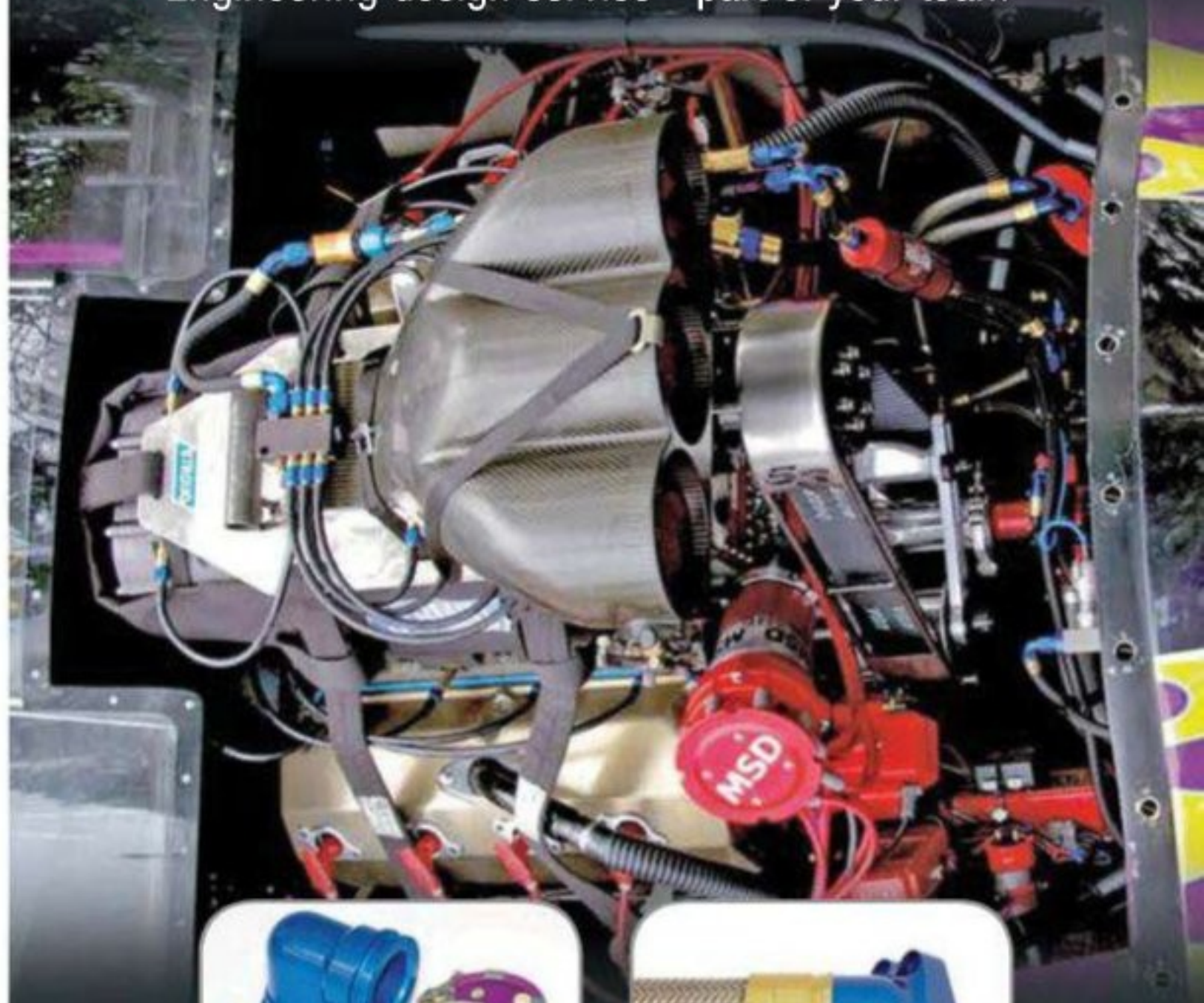


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Seen here in 2009, the ORECA customer Peugeot 908 (with orange livery) features the old rear wing uprights, while the two factory cars sport the new swan neck uprights

We started with a 2008 wing profile that had been used by a named LMP effort who will remain anonymous. The first case tested was the 2008 profile to the 2008 full width (2000mm) span and 300mm chord, mounted to a conventional bottom rear wing mount. In isolation, this case generated 1739lb of downforce and 226lb of drag, 7.69:1 L/D.

REALITY CHECK

Okay, so we shouldn't get too fixated on the absolutes. But, for a reality check, the numbers were put in front of someone with knowledge of what a contemporary LMP car rear wing should generate, and their response was: 'The absolute forces you calculated seem reliable to me.' And throughout this process we had people with relevant knowledge looking over our work, making sure we didn't lose the plot too much.

Next, we lopped 400mm off the wing span and scaled the '2008' profile to the 2009 regulated wing chord (250mm). Naturally, this wasn't a bespoke wing shape, given the ACO legality box, but we were simply looking to see what the downforce loss was if we took the old wing and made it fit the new regulations. The results was a 593lb loss in downforce (1146lb total) for a 70lb loss in drag (156lb total). Interestingly, efficiency stayed about the same at 7.36:1. This was a 34 per cent loss in rear wing downforce for a 31 per cent reduction in drag,

but only a four per cent loss in efficiency. On this, Dome's Hiroshi Yucchi commented: '34 per cent, just by wing change, is almost the same as our wind tunnel results. It sounds quite accurate to me.'

Playing the part of a design team within a major LMP programme, and with the 'encouragement' of a nearly 600lb downforce loss, it's pretty evident development would immediately commence to gain back much as much as possible of what we lost. Obviously, teams wouldn't merely scale down their old 2008 rear wings, they would look to optimise the wing to the new regulation box. And this meant getting into the wing development business. This wasn't for the faint of heart and the project could easily fall off

the rails here. At this point our experts were brought back into the fold to get an idea of what manipulations would produce the best 'bespoke' wing for the 2009 regulations. In discussions, we came to understand that the mainplane angle of attack and camber were two basic methods used to modify the rear wing to gain back the lost downforce.

So with our wing modified as directed, and everything looking

copacetic, CFD runs showed it nearly 720lb down (1019lb total) over the benchmark 2008 wing. What was going on? This should have been the ticket. A clue was in the drag figure (214lb) as it was gaining even over the previous scaled 2008 wing case. So we were losing even more downforce and gaining drag when at very least we expected increases in downforce.

FLOW SEPARATION

We suspected the culprit was flow separation. And indeed, flow visualisations showed a large disturbance in the area of the rear wing mounts. Testing our theory, two additional runs were tested that backed the mainplane angle out, first 1.5 degrees and then three degrees, rotating around the trailing edge, all the

while keeping the flap angle and all other parameters constant. The 1.5-degree reduction showed little better than a repeat: +3lb downforce, -8lb drag (1022lb and 206lb respectively). But most interestingly, with the three-degree reduction, suddenly the bespoke 2009 wing came alive, with downforce increasing by 205lb and drag dropping 27lb (1227lb and 179lb).

But in reality we had been

tutored to look for this. And this was the answer to why the swan neck rear wing mounts came into being. With the use of higher camber rear wing mainplanes and higher angles of attack, the conventional method of mounting the rear wing proved to be a source of flow separation.

And so, it was with much anticipation that we tested the swan neck wing mount case. Things immediately began to get even better: 1299lb of downforce for 186lb of drag. The flow separation went away and, at this point, we were 'merely' 440lb down on the 2008 full-span case. In terms of efficiency, we weren't that badly off, only eight per cent down on wing L/D. And matching drag through an increase in flap angle (+8 degrees) saw downforce further increase to 1413lb. At that point, we were within four per cent of our 2008 rear wing drag level, so there was a tad more to be gained, downforce-wise (perhaps, L/D was now down 15 per cent compared to the '08 case, suggesting we were coming to the end of this set up's potential), but we moved on to other areas of development.

We also tried a number of rear wing end plate iterations, but saw little benefit. This isn't to say this couldn't be an area of successful development but, in our limited running (all straight line), we saw nothing promising.

We also tested a reverse swan neck, one that came up over the trailing edge of the wing. Overlooking the practicalities of locating such a mount on a contemporary LMP gearbox, given rear overhang maximums and desired rear wing position, it essentially didn't perform any worse than the standard swan neck. The results were 1288lb downforce, for 186lb drag.

THE RESULTS

In the end, with only our limited number of runs, we were able to claw back 16 per cent of the initial 34 per cent loss when matching for drag. Certainly, with further development on the wing (we only contemplated extruded 2D sections, after all), as well as entertaining other areas of the car, gains well beyond what

"we were able to claw back 16 per cent of the initial 34 per cent loss"

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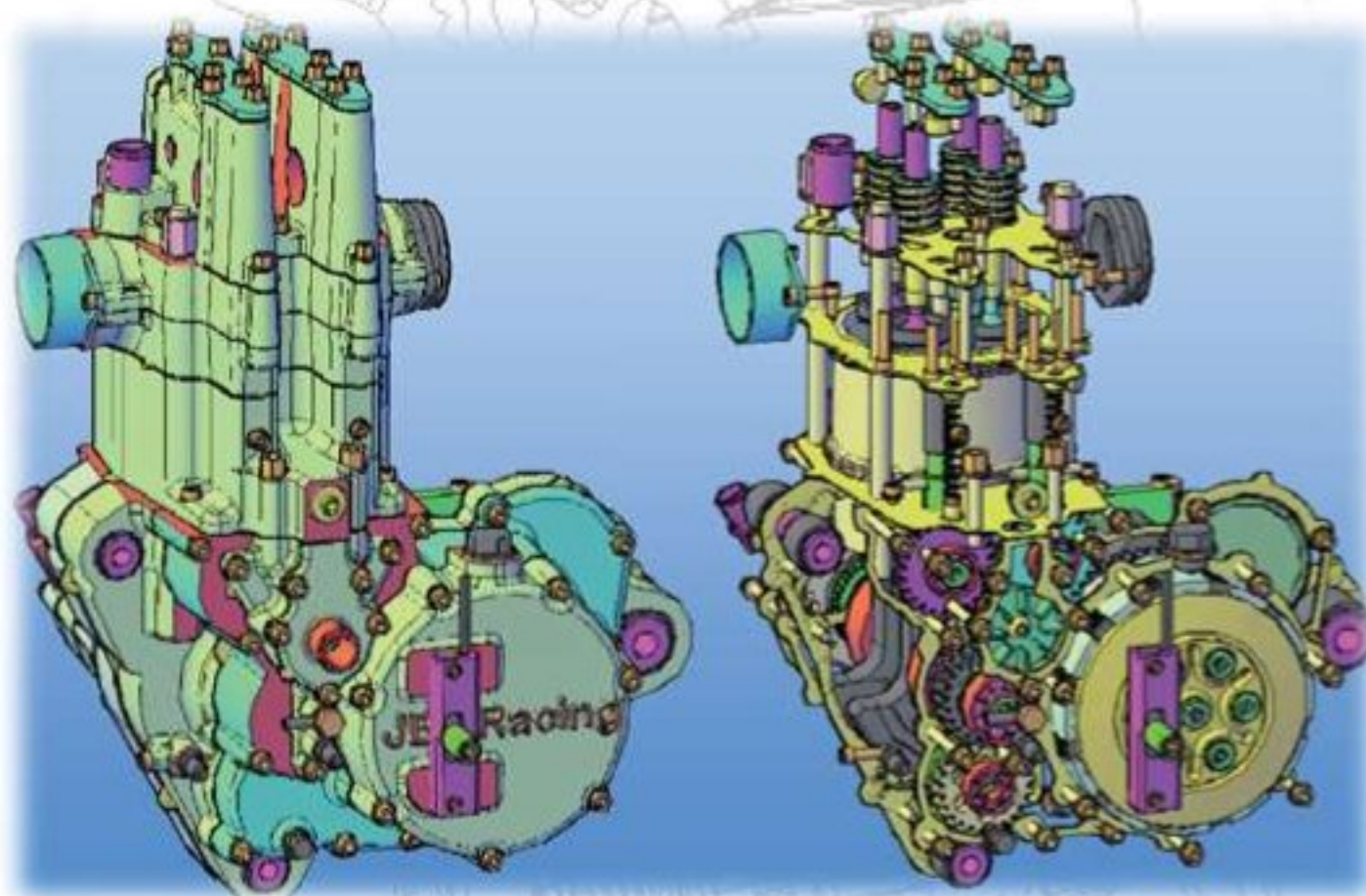
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we found were within reason. And while we were unable to extract answers as to how much downforce the major LMP efforts gained back, in hindsight it could be seen as tacit admission that the ACO's 2009 regulations did very little to actually strip the cars of downforce.

Indeed, with Dome's withdrawal from Le Mans competition, and subsequent release of aerodynamic figures for their S101 and S102 series

of LMPs, we had laid out in front of us what the net effect was to one competitor - between the 2008 S102 and the unraced 2011 S102i, Dome saw a 24lb gain in downforce for a 50lb drag increase in their Le Mans configuration. Dome's Hiroshi Yucchi: 'Due to the small rear wing, we initially lost around four per cent efficiency. Then we managed to recover three per cent by the rear fender, wing stay design and so on.'

When all was said and done, Dome suffered a one per cent decrease in efficiency. 'It was estimated around 0.5 sec per lap [at Le Mans]. The cost? According to Yucchi, 'between 20,000,000 and 25,000,000 yen (\$239,500-\$299,400 / £150,470-£188,100) to produce one car set. This does not include the aero development costs.' This only covered tooling and one car set worth of update parts, not tunnel, CFD, or CAD time.

CONCLUSION

So was upwards of \$240,000 (£150,000) worth a one per cent reduction in efficiency, which equated to a two per cent increase in lap times and even less than that at Le Mans? When the stated goal was to reduce cornering speeds, no. Given that the 2011 regulations were coming on line, it made even less sense for the ACO to implement these changes when they did, especially given the

THE CFD - PUTTING PRACTICE INTO THEORY

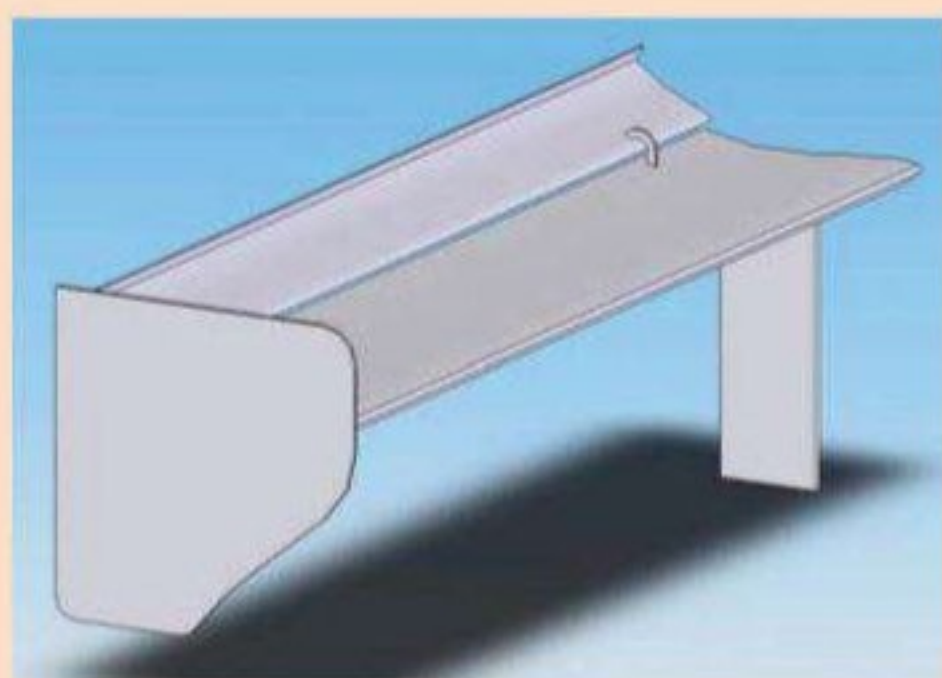


Figure 1: CAD model of half the 2008, 2m span wing (courtesy M Fuller)

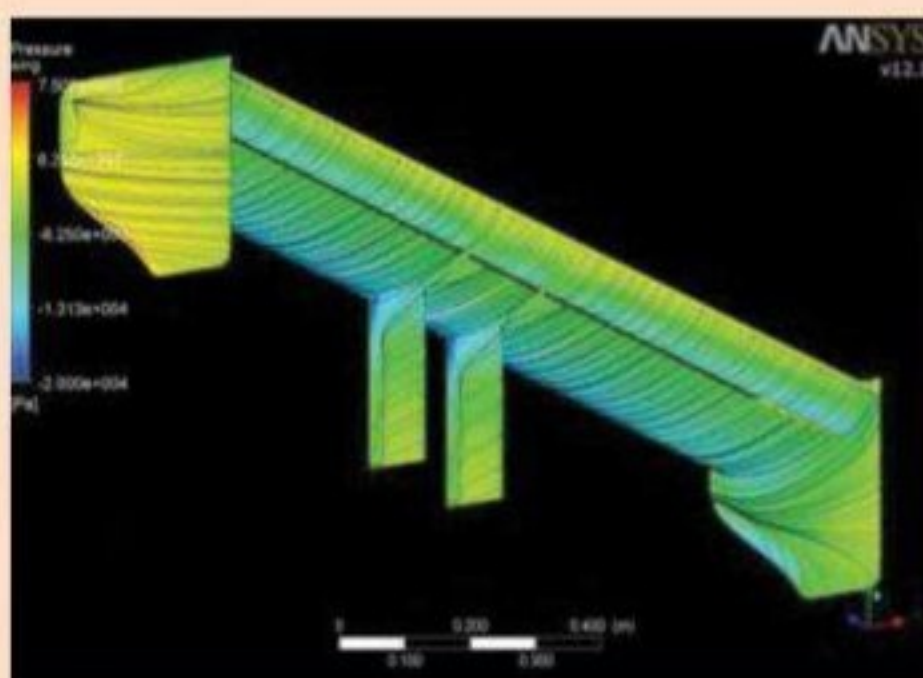


Figure 3: static pressures and surface streamlines on the 2008 2m wing underside

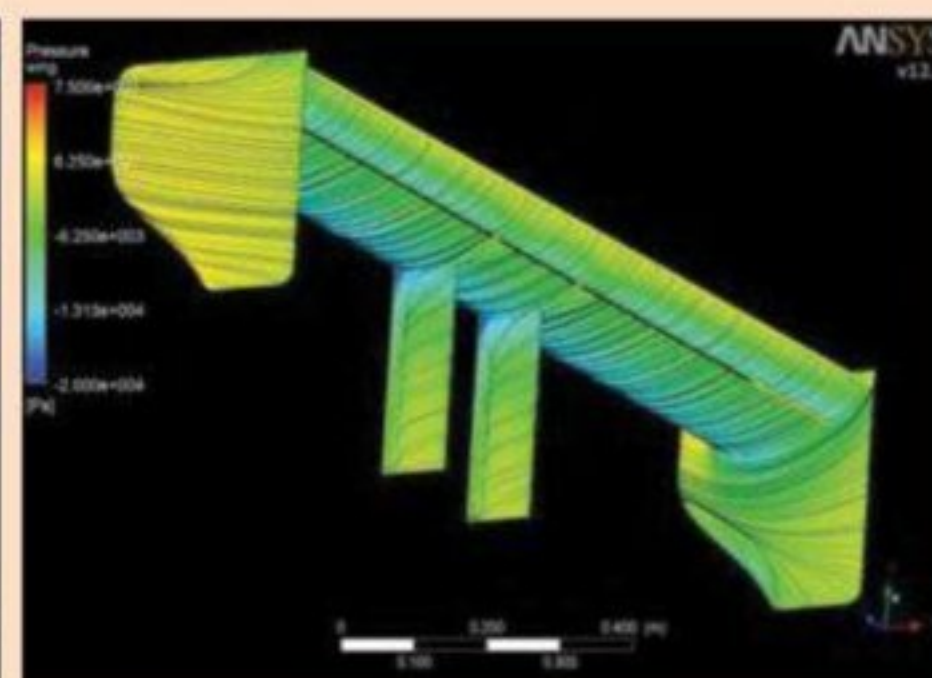


Figure 5: a similar pattern appeared on the first 1.5m span model running modest camber and angle of attack

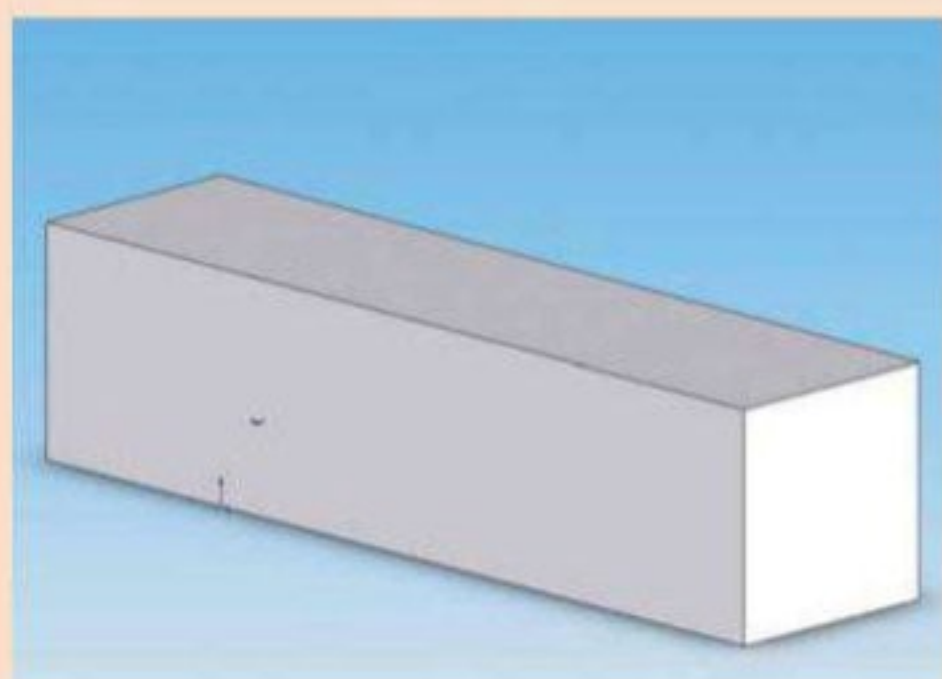


Figure 2: CAD model of the flow domain with the wing installed

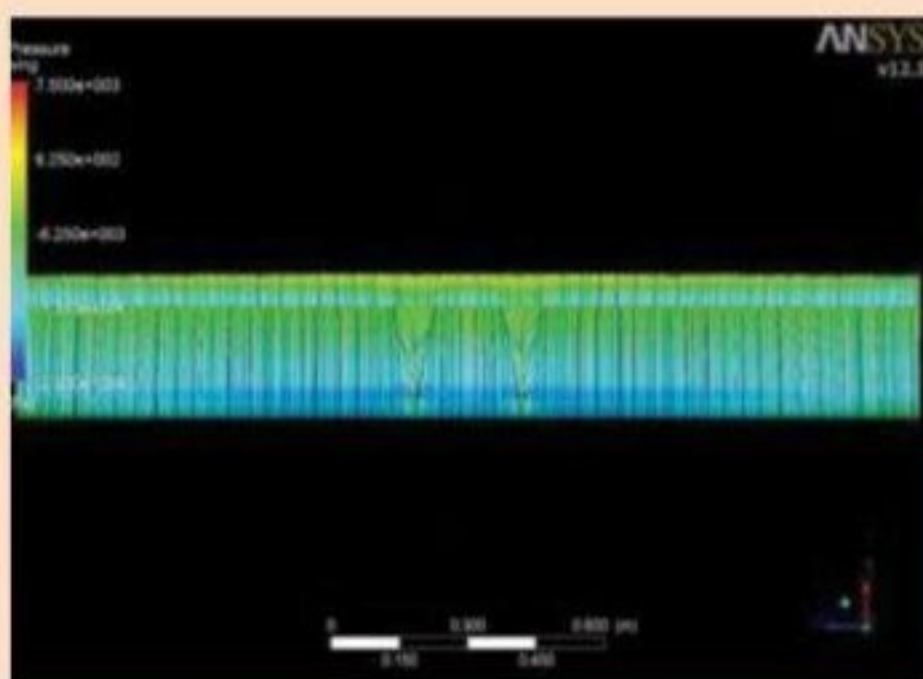


Figure 4: the wakes from the wing mounting plates are clearly visible

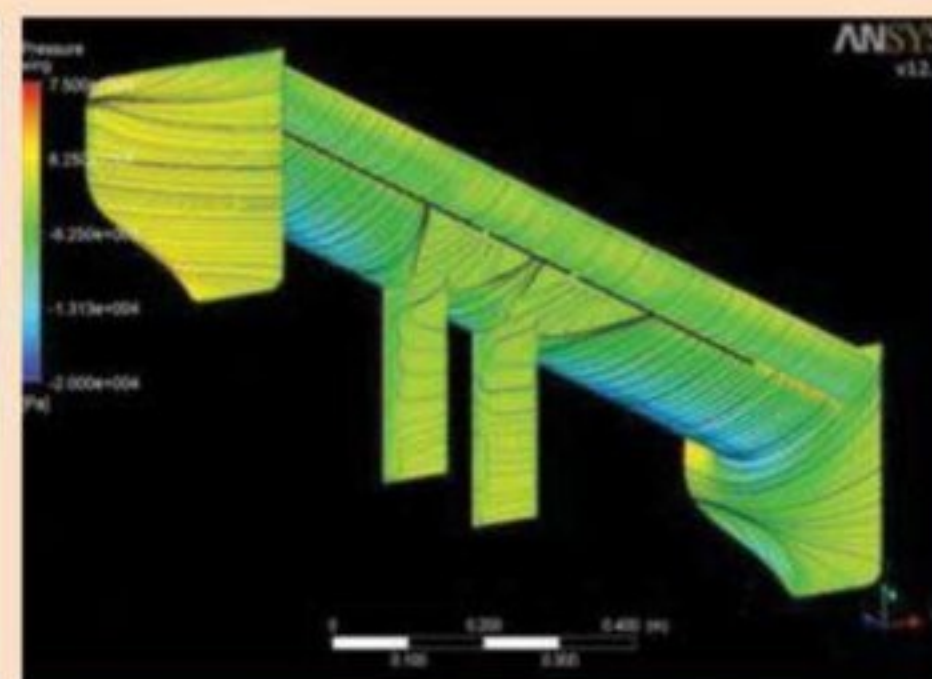


Figure 6: with increased camber and angle of attack, the wakes from the wing mountings became much more pronounced

Courtesy of Ansys CFD-Flo, part of the Ansys 12 suite, this query from Mike Fuller was relatively easily addressed by accepting that we could only realistically evaluate the wings in isolation, there being no representative car model available to us.

Full scale, half-wing CAD models were imported into a 16m x 4m x 4m flow domain - the virtual wind tunnel, if you will - and attached to one sidewall in CAD. (Note: use of half a model in symmetric cases halves the computational

requirements.) The model was then subtracted from the flow domain's volume (figure 2), which allowed the meshing software module to treat the wing as the item under test within the flow domain. Boundary layer prisms were incorporated into the mesh around the wing to capture near-surface flows and, hopefully, any flow separations reasonably realistically. Mesh settings were juggled until the size was of the order of 2.25 million elements, which was deemed adequate. CFD

aficionados might like to know that the shear stress transport turbulence model, said to deal well with models such as this, was invoked. Boundary conditions included a 200mph inlet velocity but, because the wing was in isolation in the middle of the flow domain, the moving floor option was not utilised. The side to which the wing was attached was set as a frictionless wall.

The options were worked through sequentially and the forces on the wing models calculated (these have been

reported as downforce and drag in the main text). One of the other principle benefits of CFD is the ability to visualise what's going on, and in this particular exercise this proved to be especially illuminating.

Figure 3 shows the 2008 2m wing with static pressures and streamlines plotted on the surfaces of the wing (which has been mirrored so that the appearance of a whole wing is given). The relatively small wakes caused by the mounting plates can be seen in the centre of the wing, and show up more

economic climate. A much more cost-effective change would have been the simple implementation of inlet restrictor reductions aimed at bringing engines closer to the proposed 2011 power levels. This would have been a reduction of between 100-150bhp (from 700 to around 550bhp). The cost would have been negligible and, coupled with a regulation mandating an engine freeze up to 2011, there would have been no

incentive for expensive engine development. According to Engine Developments Ltd's John W Judd, 'Changing restrictors is very cheap compared to the change in wing design, particularly as for some teams the first opportunity to test the new design at high speed may be the Wednesday of Le Mans week, three days before the race starts.' Engines would have needed to be re-mapped, of course, but, as Judd points out, 'We are used to the restrictor size

changing almost on an annual basis, so the work to optimise the engine for a new restrictor is something we are used to, and wouldn't be an additional cost to the teams.'

But Zytek's Tim Holloway offers a slightly different opinion on the matter: 'You are right in that they could have proposed a simple, large power reduction, which would have reduced lap times. But, as always, we chassis people would then want to take

drag out of the car... and that would lead to a high cost aero programme. So whichever route you take there is no cheap, simple solution, other than where we started out.'

Perhaps, but the cost burden would have shifted from a high mandated cost to a more reasonable elected cost. With the way the rules were implemented, the 2009 aero regulations simply became a \$240,000 rules compliance fee. 

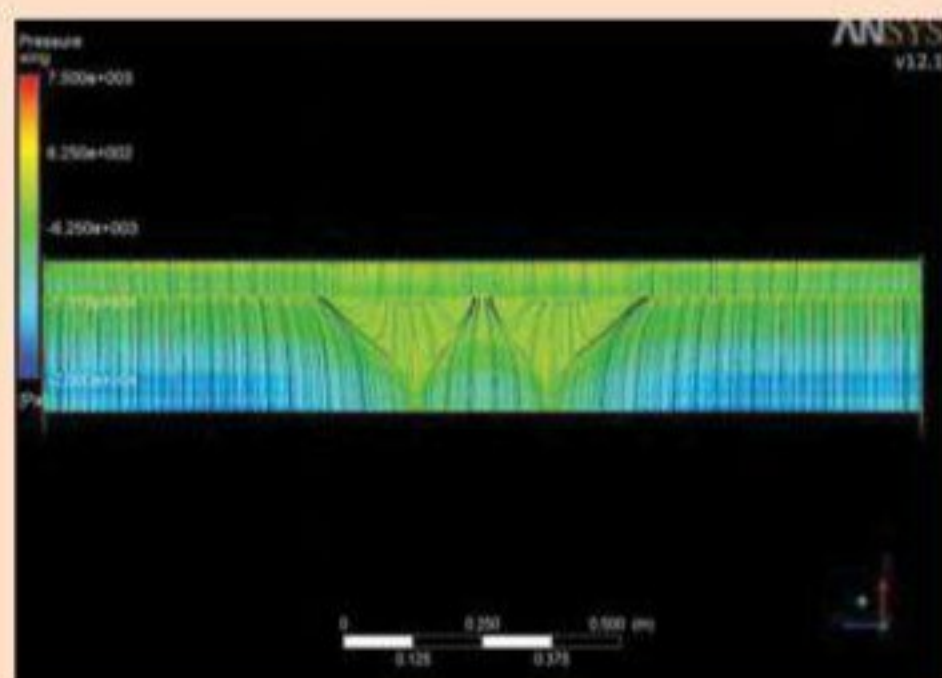


Figure 7: viewed from below, it is apparent that up to a third of the span was affected

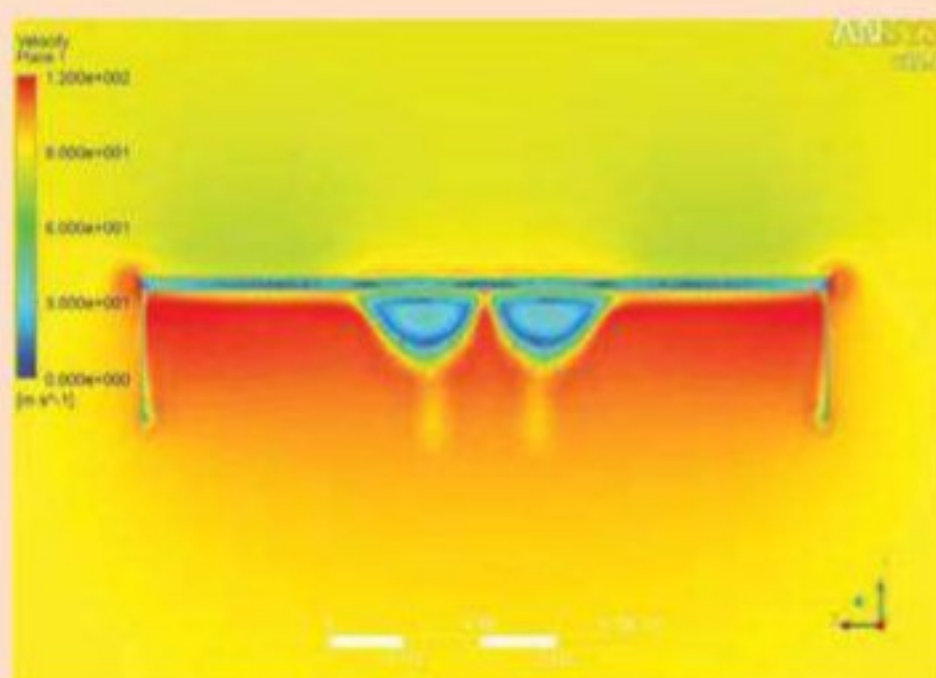


Figure 9: the velocity profile in the transverse plane level with the wing's trailing edge shows two large triangular 'holes' in the airflow

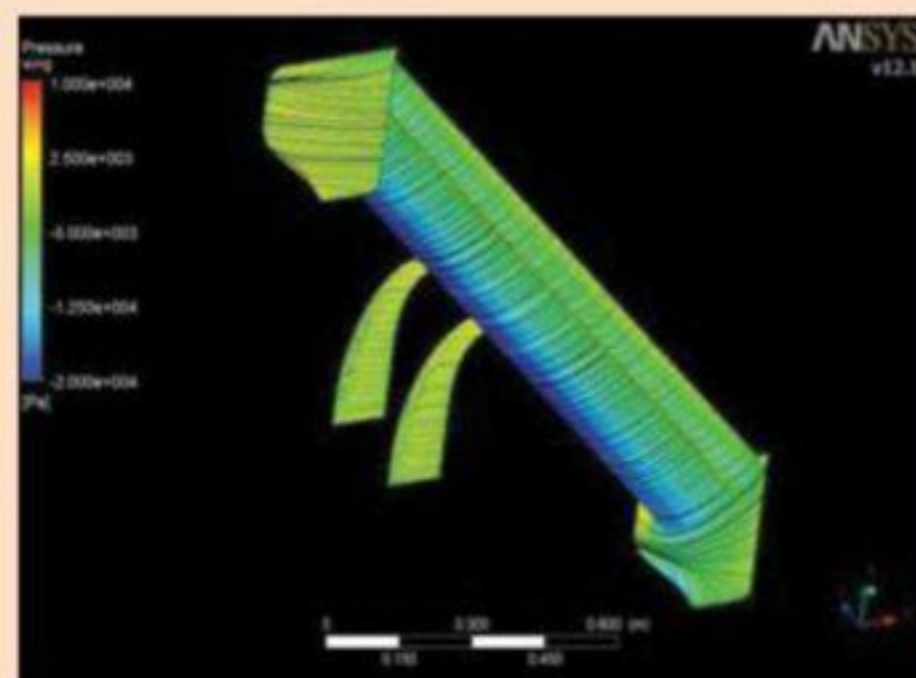


Figure 11: set the same as in figures 6-8, using swan neck mounts has eradicated the flow separation, and the wakes from the mounting plates are much reduced

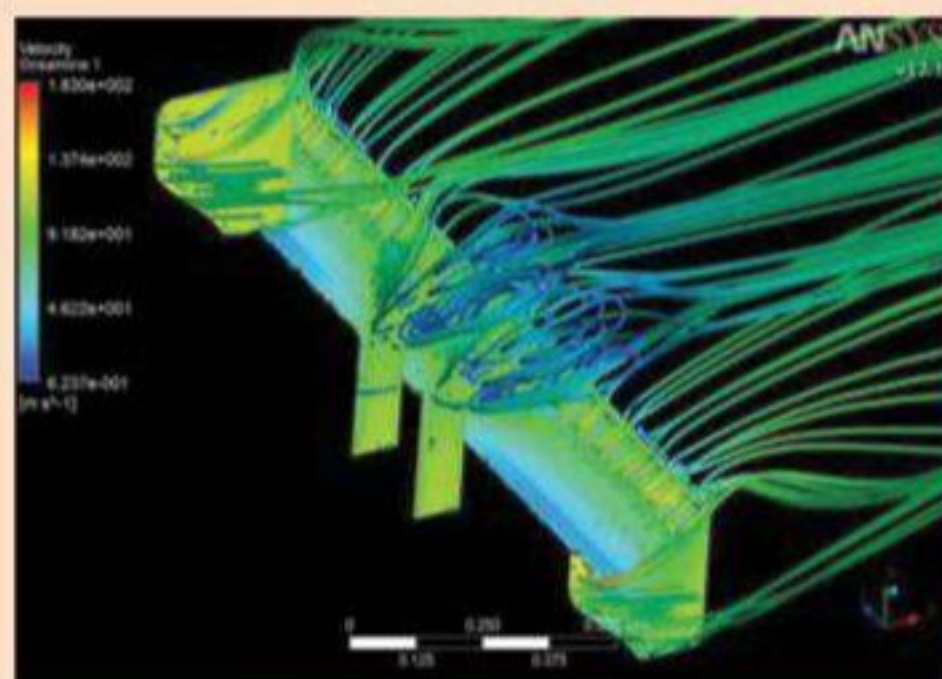


Figure 8: off-surface streamlines show even more graphically how much of the region below the wing was affected

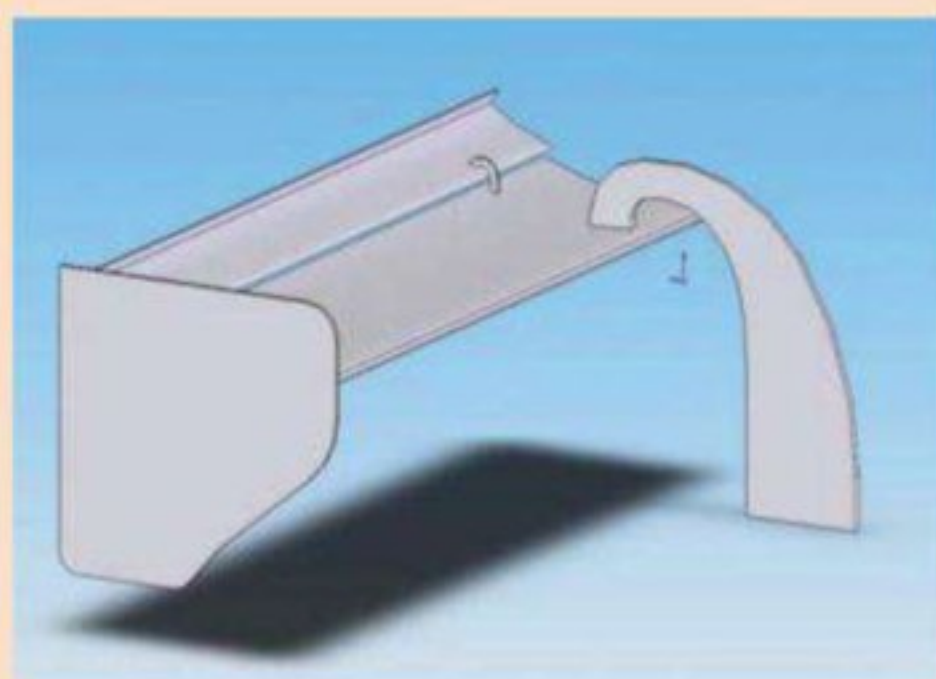


Figure 10: the new swan neck mount half model (courtesy M Fuller)

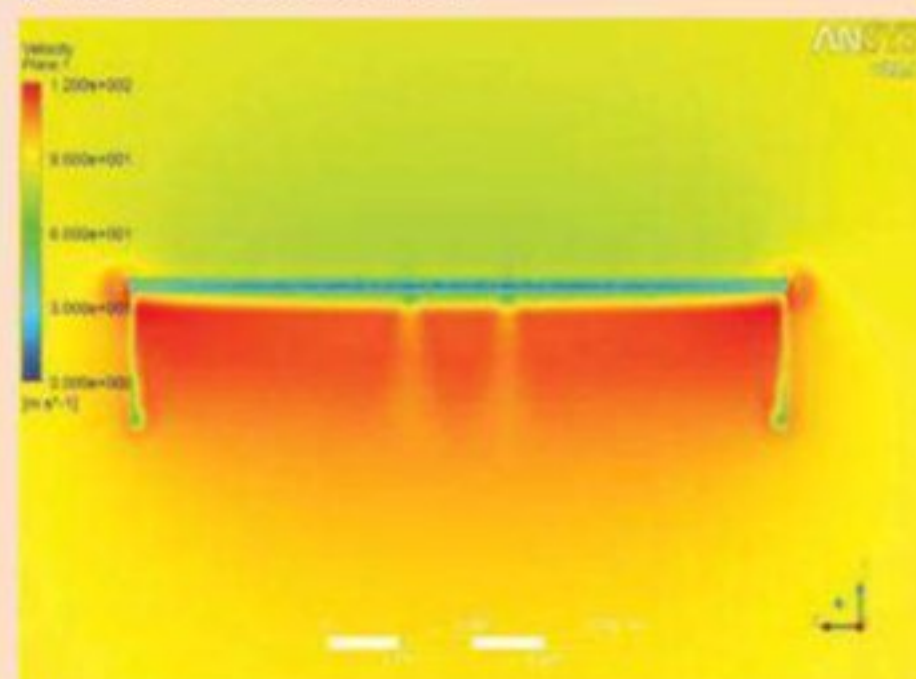


Figure 12: the velocity profile in the transverse plane level with the wing's trailing edge shows the much less pronounced effect of the swan neck mounting plates compared to figure 9

clearly in figure 4. These wakes had only a very minor effect on the pressure distributions on the underside of the secondary flap element. The same was essentially true of the second model, the 1.6m wide wing using the 2008 profile, although there was a slightly greater proportionate effect caused by the effect on the narrower span.

However, the third model, which saw increased camber and angle of attack used to try and recover the downforce level of the 2m wing, showed a rather more surprising effect.

Figures 6 and 7 illustrate, and the wakes from the mounting plates can be seen to have a much more widespread effect.

"The switch to the 'swan neck' mounts produced a potent remedial action"

Figure 8 gives a 3D view using off-surface streamlines, and the flow across the whole centre section of the wing has been thoroughly compromised in this

configuration. Figure 9 shows the velocity profile across the transverse plane at the wing's trailing edge, and two large

triangles can be seen to have been 'punched' in the airflow under the centre of the wing. Reducing angle of attack on the mainplane enabled the

flow to substantially re-attach here, but this still meant that the mounting plates were compromising performance.

The switch to the 'swan neck' mounts produced a potent remedial action, eradicating signs of flow separation entirely, as figure 11 shows quite clearly. The streamlines show no disruption from the mounting plates at all, and even the transverse plane velocity plot at the trailing edge in figure 12 shows a minimal wake from the swan neck mounting plates.

– Simon McBeath

Team bosses believe Formula 1 can weather financial storm



Formula 1 team bosses believe their organisations will remain financially healthy and the sport will be able to find backers in its European heartland, despite the continuing problems in the Eurozone.

Speaking at the Abu Dhabi Grand Prix, McLaren boss and FOTA chairman, Martin Whitmarsh, acknowledged that economic conditions were difficult. But he added that he thought F1 teams will survive because they react well in a crisis, and have already proved this during the economic turmoil two years ago. 'Firstly, it is incredibly tough out there for any team to go out and get the funding to come racing. One thing I would observe, though, is that we had a crisis - or the world had a crisis - at the end of 2008 and the beginning of 2009. We had Honda, Toyota and BMW all exiting right at a critical moment for the world economy. In some

ways, I think it brought the best out of Formula 1. We react well in a crisis.'

Some have suggested that Formula 1 may now have to look for more backing from outside Europe, but Williams' boss, Frank Williams, believes there will still be sponsorship to be found in the Eurozone: 'I believe it [the

car manufacturer's market as economics: 'I think that it is not only a matter of Formula 1, but the world is moving, changing, and that Formula 1 as another business company has to, let's say, adapt or try to anticipate the move in order not to be the last to arrive where there is a new market of potential interest. We

"we had a crisis... It brought the best out of Formula 1"

money] will still come from Europe because the sport is based in Europe, and most people who watch it are from Europe.'

However, Ferrari team principal, Stefano Domenicali, says his team is actively seeking more backing from areas outside of the Eurozone, although this is as much to do with the

were one of the first companies that had the opportunity to receive investment from this area [Middle East] and now we are looking also in the other parts of the world, because we as Ferrari have a business that is not only Formula 1 but, above all, is a car manufacturer that is selling cars in different markets.'

Meanwhile, Ross Brawn, team principal at Mercedes, says that Formula 1 could always change the Resource Restriction Agreement (RRA) if money became exceptionally tight: 'If we need to, that can be tightened even further, if we see that it's justified. So I think the teams are incredibly resilient and can cut our cloth to suit the climate, and that's what will happen.' A FOTA meeting to discuss the RRA, which was scheduled to take place at Abu Dhabi (see *Racecar Business* V12N12) was cancelled, but as *Racecar Engineering* went to press it looked likely that it would now take place at the Brazilian Grand Prix.

There has been controversy over the scope of the Resource Restriction Agreement and how it is policed in 2011, and there have been worries that failure to come to an agreement might lead to a rift in FOCA.

Chevrolet first to break cover with 2012 Daytona Prototype

Chevrolet unveiled its 2012 Corvette Daytona Prototype at Daytona International Speedway mid-November. The Corvette Daytona Prototype will make its race debut in the 50th anniversary of the Daytona 24 hours on January 26-29, 2012.

'Racing and performance are the founding principles of Chevrolet, and bringing the Corvette Daytona Prototype to Grand-Am is a tremendous opportunity,' said Jim Campbell, Chevrolet vice president, performance vehicles and motorsports. 'The opportunity for innovation is what makes the Daytona Prototype Class such a good fit for Chevrolet. Sportscar and Endurance racing is an outstanding platform for manufacturers like us to test and learn. The design of this racecar incorporates iconic Corvette styling cues and will be immediately recognised by Sportscar enthusiasts and fans of Grand-Am Road Racing. We are excited to see the Corvette DP compete in the legendary Rolex 24 at Daytona next January.'

The new Corvette Daytona Prototype participated in a Grand-Am test at Daytona on

November 16. 'Grand-Am's new Daytona Prototype concept is aimed at allowing manufacturers to showcase their brand in an exciting, cutting-edge fashion,' said Grand-Am president, Tom Bledsoe. 'Chevrolet, with its new Corvette DP, has done just that. The anticipation of seeing this new Daytona Prototype compete is building each and every day. This announcement

"the opportunity for innovation is what makes it such a good fit for Chevrolet"

has immediate and far-reaching implications, with the potential to change the face of Sportscar racing.'

Four teams will campaign the Corvette Daytona Prototype in 2012: Spirit of Daytona Racing; SunTrust Racing; Gainsco / Bob Stallings Racing and the Action Express Racing teams.

'The 2012 Corvette Daytona Prototype was developed by a multi-faceted effort involving Chevrolet, Corvette designers, Pratt & Miller and Grand-Am, and Chevrolet also worked closely with chassis builders Riley,

Coyote and Dallara,' said Mark Kent, GM Racing director.

'The IMSA GTP Corvette Prototype campaigned by Hendrick Motorsports in the '80s was the inspiration for this new Chevrolet Corvette Daytona Prototype. And, like the GTP Corvettes, the new Corvette Daytona Prototype contains numerous styling cues from the street version of the Chevrolet Corvette.'

Corvette has a long, history of racing-related feats in Daytona. Zora Arkus-Duntov - the father of the Corvette and chief engineer working on the Corvette in the '50s and '60s - set a flying mile speed record of more than 150mph in a Corvette on Daytona Beach, one of a number of record runs on the beach for him.

When Daytona International Speedway opened in 1959, Arkus-Duntov set the fastest laps - 155mph - in a Corvette SS. In 2001, a Corvette driven by Ron Fellows, Johnny O'Connell, Chris Kneifel and Franck Freon was the overall winner in the Daytona 24-hours. Another Corvette finished fourth that year, driven by Dale Earnhardt sr, driving with his son Dale Earnhardt jr, Andy Pilgrim and Kelly Collins.

BRIEFLY

Name game

The long-running dispute over the use of the Lotus name in Formula 1 has finally been resolved, and the F1 Commission has approved the re-branding of the Renault F1 team as Lotus. Meanwhile, the team formerly known as Team Lotus - Tony Fernandes' outfit - will now be called Caterham, the Malaysian businessman also owning the British sports car company.

In other name-change news, the Virgin team will now be known as Marussia, in deference to its Russian car maker, which is also a part owner of the team. Virgin will remain involved as a sponsor.

Inject and draft

NASCAR Sprint Cup teams have again tested the new EFI systems to be used across the board in 2012, trying them out at the largest and smallest tracks on the tour: the 2.66-mile Talladega Superspeedway and the flat, half-mile oval at Martinsville. Ten cars from the major teams took part in the tests. During the final 30 minutes of the Talladega test, some teams used a lower rear spoiler, something that might be used in 2012 to help limit the two-car drafting that has plagued the superspeedway races throughout 2011.

Xtrac IGS wins award

Transmission technology specialist, Xtrac, has received the Powertrain Innovation of the Year Award, presented for its instantaneous gearchange system, known as IGS. The award was presented at the Professional MotorSport World Expo 2011 held in Cologne, Germany this week. 'Like many other technical innovations by the motorsport industry, Xtrac's seamless gear shifting system could well have wider application in the automotive mainstream,' said Graham Heeps, jury member and editor of *Professional Motorsport World*.



With clear styling cues from the road car, the new Corvette Daytona Prototype will undoubtedly have huge fan appeal

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Ferrari pushes for three-car Formula 1 squads

Ferrari president, Luca di Montezemolo, has called for three-car teams in Formula 1, stating that the slower cars at the back of the grid are bad for the image of the sport and that the field should be made up of extra cars from more competitive teams.

Speaking at the Ferrari World Finals event at Mugello, Montezemolo said: 'There's the issue of the third car which, mark my words, we support, not so much for our own

interests, but more

for those of the sport in general.

We believe the interest of the fans, media and

sponsors could increase if there is a bigger number of competitive cars on track rather than cars that are two or three seconds off the pace, being lapped after just a few laps.'

Other teams have greeted the suggestion cautiously, pointing out that such a move is sure to disadvantage the smaller teams. But Ross Brawn, team principal at Mercedes, did not dismiss the idea out of hand. 'I don't think third cars are out of the question,' Brawn said. 'But I think what we mustn't do is create a situation that harms the financial and sporting environment for the

smaller constructors, because if we do something that makes their situation far more difficult then what have we achieved? We have achieved a smaller group of manufacturers and I don't think that's good. It can be a solution if we are getting short of cars, but I would far rather see a healthy group of constructors and as many as we can, that's my personal view.'

When asked if Montezemolo

"it is important to understand the pros and cons"

was serious in calling for three-car teams, Ferrari team principal, Stefano Domenicali, said: 'Yeah, absolutely. He has stated that and, for sure, this is an element for discussion.' However, he also made it clear that the subject has not been discussed by FOTA, before adding: 'It is a point of discussion for the future of Formula 1 but, as always, I think it is very important to understand the pros and cons of all these things, and it is fundamental to discuss with all the stakeholders, the constructors and the teams that are involved in Formula 1.'

It's understood that Ferrari

sees the use of third cars as a way of creating extra revenue, and there is a rumour in the paddock that it hopes to run a third car - or a satellite team, which would mean four cars - with Abu Dhabi sponsorship.

However, McLaren team boss and FOTA chairman, Martin Whitmarsh, believes F1 should concentrate on keeping variety in the sport. He said: 'I think we have got to act responsibly.

I think the DNA requires the variety of teams... If, today, Ferrari, Red Bull, McLaren [and] Mercedes

all fielded third cars then I think it would be damaging for the sport. There are pros and cons and I think it is right to have the debate and people have different views, but at the moment I think what we should be concentrating on is ensuring that we have got a viable and sustainable model for all of the teams in Formula 1.'

Virgin Marussia boss, John Booth, agreed: 'I think we have a very healthy grid of cars at the moment. I don't really see any need to change the formula. From our point of view it is important that every entrant is a constructor.'

Government funding for Rally GB

The UK Business Minister, Edwina Hart, has announced a funding package of £1.4 million for the 2012 Wales Rally GB. The rally has been held in Wales since 2000, with the event evolving over the past decade. 'I'm pleased that we can announce this funding today and look forward to working with International Motor Sports on the 2012 event,' said Hart.

'Wales Rally GB has the ability to engage with many communities throughout Wales during its week-long visit. The rally delivers benefits throughout Wales and has a strong tradition of involving volunteers from a wide range of groups. The organisers of Wales Rally GB say they aim to make the sport open and accessible to everyone.

'Developments such as the RallyFest events in Cardiff and north Wales are an added attraction for many. They have widened the Rally's appeal to reach beyond the motorsport enthusiast and are a welcome boost for retailers and accommodation providers at a quieter time of year. The rally provides an ideal platform for Wales to showcase its wide range of capabilities and technologies to the global automotive market.

'With the funding now in place, we can look forward to an even greater event in 2012.' The funding package will be made up of a guaranteed cash sum of up to £1.2 million and additional performance-related payments of up to £200,000 linked to ticket sales and the generation of other commercial revenue, including private sector sponsorship.

SEEN - DACIA LODGY GLACY

Dacia recently unveiled this little rocket sled - an MPV with which it will compete in the Trophée Andros ice racing championship. The spaceframe car features a mid- to rear-mounted, Sodemo-prepared, 24-valve V6 giving 355bhp, transferred through all four wheels via a Sadev six-speed sequential gearbox. As for that name, who knows?

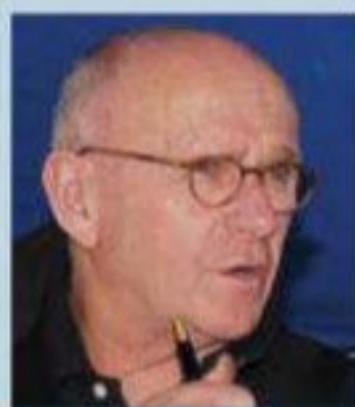


RACE MOVES

Williams has announced the appointment of two new directors to its board.

Nick Rose joins **Toto Wolff**, **Mike O'Driscoll** and **Eddie Charlton** as the group's fourth non-executive director, while **Louise Evans** has stepped up from her former position as head of finance to become finance director.

Derrick Walker is to run the new IndyCar team that driver Ed Carpenter has set up for the 2012 season. Ed Carpenter Racing will make use of Walker's equipment and workshop, while Carpenter will concentrate



Derrick Walker

on the driving. Although Walker has not run an IndyCar since 2008 he has a huge amount of experience in the category.

Sam Michael was able to join his new team, McLaren, for the final two races of the F1 season after his former team, Williams, gave him permission to start work early. Originally, Michael was to be on 'gardening leave' until March 2012 but, after discussions, the teams came to an agreement.

NASCAR team boss, **Rick Hendrick**, and his wife, Linda, were lucky to escape serious injury when their jet overshot the runway at Key West in Florida. Hendrick spent six days in hospital where he was treated for four broken ribs and a broken clavicle. The plane, which was co-owned by Hendrick and five-time Sprint Cup champ, **Jimmie Johnson**, was badly damaged in the accident.

Mike Coughlan has been promoted to technical director at Williams, taking on the position left vacant by the departure of **Sam Michael** earlier this year. Former McLaren man,

Coughlan, was originally taken on as chief engineer at the Grove-based concern.

John Wickham has left his post as team manager at the Renault Formula 1 team. It is understood that Wickham, who was formerly technical and operations manager for A1GP and also one of the founders of the Spirit F1 team in the early '80s, now plans to take on a role in Sportscar racing.

Paul Seaby is the new team manager at Renault, following the departure of **John Wickham** (see above). Seaby has been at the team since 1992, when it was known as Benetton, originally signing up as number two mechanic.

Charles Day, a crew member on the no 66 car in the NASCAR Sprint Cup, has been indefinitely suspended from NASCAR after he was found to have violated the substance abuse policy.

Julian Gill is now global CEO of the Eibach Group. Gill, who was formerly managing director at Eibach UK and then director of global sales for Eibach, has been with the company since 1988 and takes over the position from outgoing CEO, Wilfred Eibach, who will continue to have an involvement in the day-to-day running of the firm.

Former Renault sporting director, **Steve Nielsen**, has joined Lotus - soon to be known as Caterham - where



Steve Nielsen

he will fill the same role. He replaces **Dieter Gass** in the position. Nielsen was at Renault for over 10 years, joining when the team was still known as Benetton.

Christopher Tate has been appointed managing director at Donington Park Racing, where he

The future looks bright for young Xtrac engineer

The youngest member of Xtrac's Formula 1 design engineering team, Adam James, has been highly commended as a Young Designer of the Year finalist at the British Engineering Excellence Awards.

It's not James' first commendation. In 2009 he was part of the team from the University of Hertfordshire that secured the Formula Student award for its electric car, entered in the alternative

as a production engineer.

'We're delighted Adam has received this special commendation in this hotly contested category,' commented Xtrac technical director, Adrian Moore. 'Despite his relative youth, Adam is already highly experienced in key aspects of the design process, and gained a high level of manufacturing knowledge whilst undertaking his industrial placement at Xtrac.'

'In addition to his production know how helping the design process, James has gained considerable practical experience supporting race teams at the track,' said Xtrac chief engineer, Martin Halley, who attended the awards ceremony. 'This all-round experience has helped him create a new transmission lubrication oil pump for a Formula 1 gearbox. The design



Rising star: Adam James of Xtrac design engineering team

brief required the pump to be small and light, meet stringent performance and durability requirements within significant cost constraints, be easy to maintain and also act as an integral structural part of the transmission. This was a tough challenge for a young design engineer, but he successfully delivered and the pump has since been used by three Formula 1 teams.

There were a record number of entries this year for the BEEA awards, which were held yesterday at the Shakespeare Globe in London, where the judges commented on James' 'notable design engineering accomplishments, including the development of a range of innovative technologies.'

James graduated in 2009 with a MEng in motorsport automotive engineering from the University of Hertfordshire. He started as an undergraduate trainee at Xtrac in 2006 and was sponsored by the transmission technology specialist throughout his studies for his masters degree. His undergraduate training was

brief required the pump to be small and light, meet stringent performance and durability requirements within significant cost constraints, be easy to maintain and also act as an integral structural part of the transmission. This was a tough challenge for a young design engineer, but he successfully delivered and the pump has since been used by three Formula 1 teams.

'Adam is an excellent ambassador for the company, with great interpersonal skills,' concludes Xtrac's managing director, Peter Digby. 'He is already taking on additional leadership responsibilities and currently mentoring another Xtrac engineering graduate. We currently support eight apprentice students, two graduates and eight undergraduates in our award-winning training programmes.'

2011 Rolex 24 at Daytona attracts largest audience in Grand Am's history

The Grand-Am series in the USA has closed its most successful season ever with increased attendance by fans, wider broadcast coverage, closer racing and larger grids. The championship was broadcast on Speed TV and averaged 305,000 viewers in 245,000 households for each event - a 12 per cent increase over 2010. More crucially,

the vital 18-24-year old audience increased over 40 per cent during the course of last year.

The Continental Tire Sportscar Challenge also showed substantial audience increases, with the Birmingham, Alabama event attracting the largest audience of the season with 380,000 viewers tuning in.



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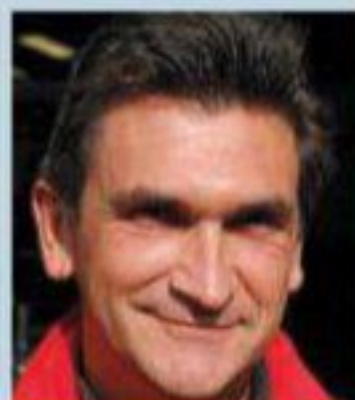
will join the company's board of directors. Tate has previously held senior posts at Elan Panoz, Lola Cars, Rockingham Motor Speedway, and Masters Historic Racing.

Former **Chip Ganassi** team manager, **Tom Anderson**, is to serve as president of racing operations at Rahal Letterman Lanigan Racing next year. He will take responsibility for the ALMS and IndyCar efforts in 2012.

Jean-Michel Jalinier is to replace Bernard Rey as president of Renault's Formula 1 division. Jalinier will report directly to the chairman and chief executive officer of the Renault-Nissan Alliance, **Carlos Ghosn**.

Chris Norman has resigned from the position of competitions secretary at the UK's 750 Motor Club. Norman, who had been in the post for just a year, replaced **Robin Knight** in the role for 2011, but has now moved on to pursue other business interests.

Jacky Eckelaert is to head up the design team on the 2012 HRT F1 car, after plans to install **Jorg Zander** in the position fell through. Eckelaert, formerly part of the Honda Formula 1 set up, will work



Jacky Eckelaert

alongside aerodynamicist, **Stephane Schosse**, on the Spanish team's 2012 challenger.

Andrew Deakin has been appointed vice chairman of Formula Student. Deakin's involvement with the event began as a competitor with the

Leeds University team before he became part of the organising committee. In 2010 he became vice chairman of the rules committee for FSAE and has played a key part in the formulation of a single set of rules for electric-powered vehicles across all Formula Student competitions worldwide.



Dave Stubbs

Former Jaguar Formula 1 team manager, **Dave Stubbs**, has set up a SPEED Euroseries race team in collaboration with **Michael Jackman**, who ran the gearbox department at Jaguar. Stubbs, who managed the team during its Stewart, Jaguar and Red Bull eras, will run the team as MJ Tech Racing.

Alistair Fergusson, managing director of Alcon Components, has been re-elected as Motorsport Industry Association (MIA) chairman. **Jim Morris**, managing director of Lifeline Safety Systems, has also been re-elected to continue as vice chairman of the MIA.

Former *Racecar Engineering* editorial assistant, **Paul Harmer**, has passed away at the age of 61. In addition to his work as a motorsport journalist, Paul was also a club level race driver in sports and saloon cars.

Kim Brink is the new managing director, brand and consumer marketing, at NASCAR. Brink joins NASCAR from GM Corporation, where she was executive director of advertising and sales promotion for Cadillac.

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New help for manufacturers could generate 23,000 new jobs

A new, nationally-operated Manufacturing Advisory Service has been announced that will focus on helping UK-based small and medium-sized manufacturers to grow. The new service will be delivered by the Manufacturing Advisory Consortium (MAC) and will help create an estimated £1.5bn in economic growth, 23,000 new jobs and safeguard 50,000 existing jobs. The Manufacturing Advisory Service will continue to deliver a national service to all manufacturing businesses in England, but the new consortium now means that there will be a specific focus on:

- driving business growth through strategic and technical support for SMEs developing advanced manufacturing capabilities and creating high value jobs
- enabling business improvement

with manufacturers operating in global supply chains

- linking SMEs with the apprenticeship programme, delivering a minimum of 1250 engineering and manufacturing apprenticeships annually.

UK Business Minister, Mark Prisk, said of the announcement: 'Manufacturing contributes half of Britain's exports and has much higher productivity than the rest of the economy, so it is essential to our plans for growth. That is why we are taking steps to ensure our industrial base is thriving as part of a strong and balanced UK economy.'

'I recently visited Arrowsmith Engineering in Coventry, who supply the motorsport and aerospace industries, and who have been able to grow their company 20 per cent as a result of support from MAS.'

CAUGHT

NASCAR Sprint Cup outfits, Michael Waltrip Racing and JTG Daugherty, have been penalised and fined for fitting windscreens that did not meet the specifications - the



'screens were apparently modified at the top to create a gap between the frame in an effort to disturb the air at the rear of the car. As a result of the transgressions, which were discovered during scrutineering at Talladega, crew chiefs, Chad Johnston, Rodney Childers and Frank Kerr have each been fined and were suspended from

NASCAR until the end of November. Car chiefs, Anthony Lunders, Steve Channing and Raymond Fox, have also been suspended, while Bobby Kennedy, director of competition for Michael

Waltrip Racing, has been placed on NASCAR probation until the end of the year. The JTG Daugherty car is prepared at the MWR facility. Each of the three cars has also been docked points in the drivers' and owners' championships.

FINE: \$50,000 (£31,700) per crew chief
PENALTY: 25 points per car

DC Electronics appoints Antipodean distributor

UK-based **DC Electronics** has appointed Ultimate Power Steering as the distributor of its electronic power-assisted steering products in Australia and New Zealand. Ultimate Power Steering is based north of Brisbane and has extensive knowledge of power steering systems. Company director, Warwick Hutchinson, alone has over 25 years' experience in the industry, and commented: 'We are delighted to be working with DC Electronics as a

distributor of their products. They have an excellent reputation within the motorsport industry and we are looking forward to generating some excellent results.' Managing director of DC, David Cunliffe, said: 'We are committed to servicing the global motorsport industry and working with Warwick and the team at Ultimate Power Steering allows us to continue to fulfil that commitment.'

For more on Ultimate Power Steering, see www.ultimatepowersteering.com.au

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DATA LOGGING

Bosch logger

Bosch Motorsport unveiled two new data loggers at the PMW show in Cologne, Germany - the DDU 7 Sport Line dash logger and C 50 data logger. The dash logger is based on the same platform as the company's DDU 8 Performance Line model and integrates a fully programmable colour dashboard with a data logging system. Features include a 5.7in, full colour, trans-reflective TFT display, 10 multi-colour LEDs, fully configurable display pages and shift / warning lights. It allows for synchronised acquisition and visualisation of engine data from the ECU and chassis data from six analogue and four digital wheel speed input channels. Additional input devices can



be connected via Ethernet and two CAN buses, with data from the 2GB internal flash memory downloadable via a high speed Ethernet connection. The DDU 7 has a lightweight, synthetic housing and offers recording on a removable USB flash drive as an optional upgrade.

The C 50 Sport Line data logging system offers all the features of the DDU 7, but without the visual display.

See www.bosch-motorsport.com for more information

HARDWARE

XRP protective sleeving

Racecar plumbing specialist, XRP, has produced a new range of heat protective sleeving to protect and insulate engine hoses, brake lines and wiring in high ambient heat areas.

Fyre Jacket features a smooth, extruded, silver silicone coating over a thick, open-knit glassfibre sleeve, offering excellent long-term insulation and burn-

through protection when fitted loosely over hoses or wires. Also available is the lightweight Fyre Foil II and ultra lightweight Fyre Foil Lite, both manufactured from Dual Mirror aluminised glass fibre fabric with a laminated Mylar outer film for protection.

Sizes are available to suit -3 through to -20 hosing, plus some larger sizes for duct protection.

See www.xrp.com for more information



SENSORS

Gill ultrasonic sensor

Gill Sensors has developed a new ultrasonic fuel flow sensor, designed specifically for use in racing applications. Lightweight, compact, robust and designed to withstand the extreme levels of vibration experienced in this environment, the new sensor utilises proven ultrasonic measurement technology to detect bi-directional fuel flow rate to within 0.25 per cent accuracy in real time, marking a major step forward from impeller flow devices often used in racing.

The ultrasonic technology has a number of major advantages over impeller flow sensors, the most significant of which is the removal of mechanical parts from the flow path. This ensures minimal pressure drop across the sensor, providing true flow rate data with little impact on the flow itself. The removal of mechanical moving parts and bearings also eliminates

mechanical dampening and allows much higher temporal resolution and accuracy for the measurement of high frequency pulsating flows, allowing even the pulses of fuel injectors in low rpm ranges to be identified.

The ultrasonic fuel flow sensor has been designed for use with all race fuels, including aggressive ethanol blends, and is capable of accurately recording flow rate from 0.5-3000ml/min.

The sensor also features a newly-developed electronic platform, which integrates the latest FPGA technology, capable of measuring flow rate up to 4000 times a second. In addition to a digital output, a 0-5V analogue output is provided across the calibrated flow range.

See www.gillsensors.co.uk for more information



HARDWARE

Arnold express fasteners

German company, Arnold Umformtechnik, has launched 'Fastener Express' - a bespoke fastener production service. The concept offers designers the chance to develop complex fasteners as prototypes and then to take their ideas straight into manufacture.

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Additional time savings arise from the simultaneous transformation of 3D CAD data into physical products. Blanks are then sent directly to machining, where they are turned into finished parts. A wide variety of finishing options are also available in house,

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See www.arnold-uk.com for more information



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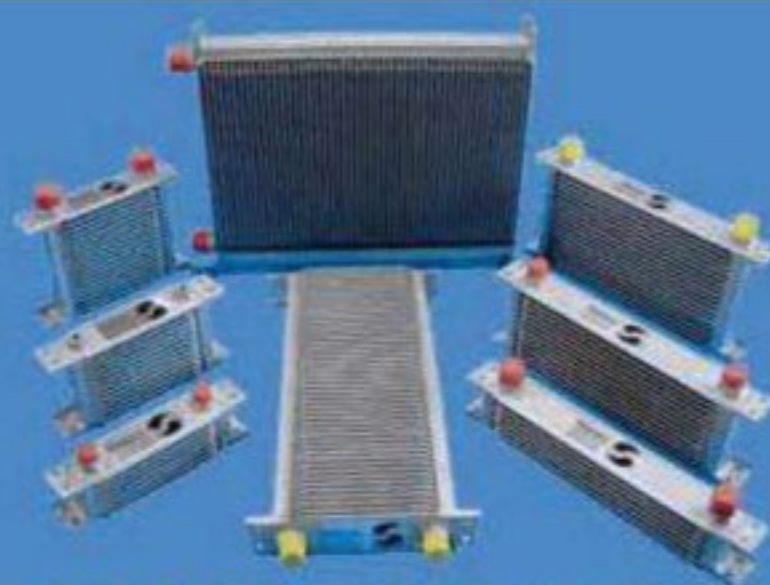
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A close-up portrait of Stéphane Ratel, a man with long, wavy brown hair and a light beard. He is looking slightly off-camera with a serious expression. He is wearing a white button-down shirt and a red lanyard with a black strap. The lanyard has a circular logo with the letters 'G' and 'T' inside. The background is blurred, showing what appears to be a race track or event area.

Marmite man

Love him or hate him, Stéphane Ratel is an innovator, an entrepreneur, and holds the FIA GT World Championship in his hands

The FIA GT1 World Championship ended in style at the Potrero de los Funes circuit in Argentina. The circuit, built in a country that has just discovered one billion barrels of oil within its borders, with a booming economy, and very little by way of racing, is tailor made for the latest evolution of Stephane Ratel's series.

Love him or loathe him, it is hard not to respect what Ratel has managed to achieve. He turned a Parisian house-warming party into a street race, and out of that came the Venturi Trophy, which developed into the BPR series, and then, in 1997, the FIA GT Championship.

When he was short of competitors, he created the N-GT class, which became GT2, and is now GTE. Despite resistance from the manufacturers, he created the GT3 regulations, the category which is now a global phenomenon and, in its latest evolution, the Blancpain Series, is looking at over-subscribed grids. He runs championships in Britain, including the British GT and F3 projects, runs Formula Renault, Renault Clio Cup and has franchises in Dutch and Belgian series running another of his creations, GT4.

Ratel, who counts Bernie Ecclestone as his best business partner, was the first to go to China, hosting a street race in Zhuhai in 1994. He was the first to take his championship to Romania, with another street track around Nicolae Ceausescu's grotesque palace. He was the first to go to Argentina and Mongolia, and aims to go to Russia and Beijing. In fact the Frenchman wants to host as many GT World Championship races as he can in emerging markets, rather than to continue to forage the European and Middle East markets.

'The European circuits are so booked by manufacturer incentives and club activities that all the circuits owners say motorsport is not worth it,' says Ratel. 'I was at this Moscow forum with the circuit owners and builders, and they were saying that for us, motorsport is a loss.'

'You are competing with other activities at prices where you can no longer make it



While the so-called 'first world' flounders and fights for oil, the developing countries like Argentina offer a real opportunity for motorsport to prosper

profitable and you no longer have government support. All the races we do outside Europe are basically the governments buying entertainment for the people, and we bring the show. This is like any other sport, which is backed by the public, like the Olympic Games, and most of the grands prix are supported by government funds. In Europe we have no more incentives, so to finance it on your own is very difficult.'

Finances have always been

most motorsport promotion is about in Europe.

'Then you have the other model, which is the FIA model, where you don't have the entry fees because they go directly to the FIA. Then you have to rely on sponsorship, TV rights and promoter fees, and then it becomes a very difficult exercise because getting TV rights is difficult, your promoter fee is almost impossible, and sponsorship depends on

"The future is to keep few events in Europe with as many people in the grandstands as possible"

a question mark, not for Ratel, who invested his inheritance wisely when his parents were tragically killed while he was a teenager, but for his teams. His is the only World Championship to be held exclusively for private teams, and relies heavily on private investment from wealthy individuals. His long-term plan is for these investors to make a return, and he has a plan to do it.

'You have two separate activities - the club business, with entry fees, and with these you pay circuits; then you make supplier deals with fuels, tyres and so on. You pay the circuit, the TV production and that is what

spectators, viewers on the track and on the television.

'The first step is that you have to create the product, and we did that. The second part was to convince promoters to take the show for free, or pay us to take the show and this is where the salesman bit comes in.

'Then you hit the reality of the market, and the reality is you need spectators and television viewers. If you have a lot of viewers, the company is going to want to pay for your product. If you have less than the average, you need to pay the difference.'

And that has been the problem - spectators have been thin on

the ground, as has the television audience. An online television platform is a method adopted by the American Le Mans Series, and by the GT World Championship, but it is not yet a substitute for television programming. Ratel has to fight back.

'Either we stop, or we go back and say we do it better. We have to identify where we went wrong. I have been traumatised by the 1997 and 1998 experience [when Porsche and Mercedes got into a spending war, and priced each other and the championship out of the market], and I am too cautious about manufacturers. So, let's try to be less cautious and, without direct manufacturer involvement, get them more involved.

'If they are involved in customer programmes, we can see that they are getting closer and closer to GT3. Number one objective is to get closer to the brand. Number two, have a product that is even more extraordinary, and that is to follow the F1 model of more brands. And it is a possibility to have both. The extraordinary success of GT3 has brought in Audi, BMW, Mercedes, Porsche, McLaren, Aston, Ferrari, Lamborghini, Dodge, Corvette, Ford, Nissan and Alpina.

'The future is to keep few events in Europe with as many people in the grandstands as possible, and try to expand in basically the emerging markets. South America is a dream continent because it has a booming economy, and they have a true passion for motorsport. I have been digging in the desert for 10 years, and you have a fantastic arena, but you don't have the feel.

'We have ideas how it will develop. We want it to look different. We have ideas for the championship to keep exclusivity, but the biggest exclusivity is the calendar. One thing we have been successful in is moving outside Europe and we need to accelerate that. It will be exclusive when it will have the majority of races outside Europe and teams coming from outside Europe to compete, and we have another idea, and that could be a big surprise.'

With Ratel, that could mean anything, but it is a brave person who bets against him.



Graham Jones award announced

During his three year stint as editor of *Racecar Engineering*, one of the tasks that Graham Jones most looked forward to was picking the most innovative product on display in the Autosport Engineering Show. Together with the staff of the magazine, every year Graham, who passed away in September, took great pride in presenting the winner with the award on the show's main stage on Friday afternoon. Earlier this year he wrote about the judging process, 'one of the more

enjoyable tasks that falls to the *Racecar Engineering* staff during the Autosport Engineering show involves choosing the most innovative product. There is often much spirited debate during the selection process regarding the merits of the respective products.'

At this year's Autosport Engineering show, as a tribute to Graham, *Racecar Engineering* will be proud to hand out the Graham Jones Award for the most innovative product.



Gravel trap By Sam Collins

England in mid-January is not the most hospitable place,

with snow-induced travel disruption and cold, rainy days a certainty. And Birmingham at that time of year is not what you might call a romantic destination. But, quite frankly, it is the place you have to be for a week.

The reason for this is the Autosport International show at the Birmingham NEC. Now, you may be thinking that I have to say this as it is written in a magazine that has long promoted the event, but actually I don't. I'm writing this because it is precisely what I think. I first attended the show as a student in the late 1990s and was taken aback by the sheer depth of it - everything from the newest Formula 1 machinery to the tiniest (but very advanced) nut bolt or washer was on display. Whilst the new F1 cars are rarely unwrapped there these days, there is still a huge amount of interest from F1 teams. You will probably find more senior grand prix technical personnel wandering the myriad aisles than at

any other show. I think last year I saw someone from every constructor there, and every engine manufacturer.

The reason for this is that Britain still has the best motorsport engineering cluster in the world, and the two-day engineering part of the show is where they choose to show off their latest products. But for me that is not the best bit of the show. In the far end of the NEC you'll find a plethora of small racecar constructors showing off their wares - new Formula Fords, Vees and Sports Prototypes attract potential drivers and some familiar faces. Watching Ulrich Baretzky, the engine boss of Audi Sport, check out the engine tuning on one of Alan Harding's air-cooled Volkswagen engines last year was a treat, and seeing Bill Riley telling one of the European Late Model Series drivers how to set up his car was also fun.

But the point of it all, of course, is business, and I think everyone who goes to this show either finds new customers or finds some new technology to go a little quicker in the coming season.

The new International Motorsport Business week is well overdue, and many of the deals will be done during its events. So, if you have never been to the show before (particularly if you are reading this outside the UK), you are already at a competitive disadvantage. So book your hotel and airline tickets and head to the West Midlands. You'll be pleasantly surprised.



Technology transfer on show

From the highest degree of engineering integrity to the paramount value of reliability, there are many shared values in the production of components for the medical and motorsport industries. The considerable cost of in-house manufacturing facilities mean many race teams rely on external sub-contractors to produce key parts, which opens up the possibility for firms in the medical industry to break into the lucrative motorsport market, worth £4.6 billion to the UK alone*.

Whether producing printed circuit boards (PCBs) for heart monitors or telemetry systems for Formula 1, the processes put in place by standards such as ISO13485 and ISO9001 ensure high calibre end products in both fields, with key quality control systems such as batch traceability, design validation and operator logging common to both industries.

One company already leveraging the technology crossover between sectors is St Cross Electronics, a leading manufacturer of wiring solutions. St Cross Electronics' current clients include medical suppliers such as Texas Instruments and Phillips, as well as the National Association for Stock Car Auto Racing (NASCAR) series in the United States.

'Medical and military

projects probably make up about 80 per cent of our business,' says Dax Ward, managing director of St Cross Electronics. 'However, having processes in place such as stock bonding, stock lifing and the ability to produce large production runs makes us ideally placed for supplying series such as NASCAR. The standards that the medical and military industries require give us a real advantage over our competitors who only serve the motor racing sector.'

St Cross Electronics has developed and nurtured its motorsport customer base by exhibiting at Autosport International, Europe's largest dedicated motorsport trade show, which takes place at the Birmingham NEC, UK from 12-15 January 2012.

Autosport International provides a networking platform for businesses in complementary sectors, such as medical manufacturing looking to expand into new markets. In 2011, 28,900 trade visitors from 50 countries attended the event, generating £800 million of business across four days.

For companies interested in exploring the possibilities offered by the motorsport industry, visit www.autosportinternational.com for information on how to go about booking a trade stand and obtaining tickets.

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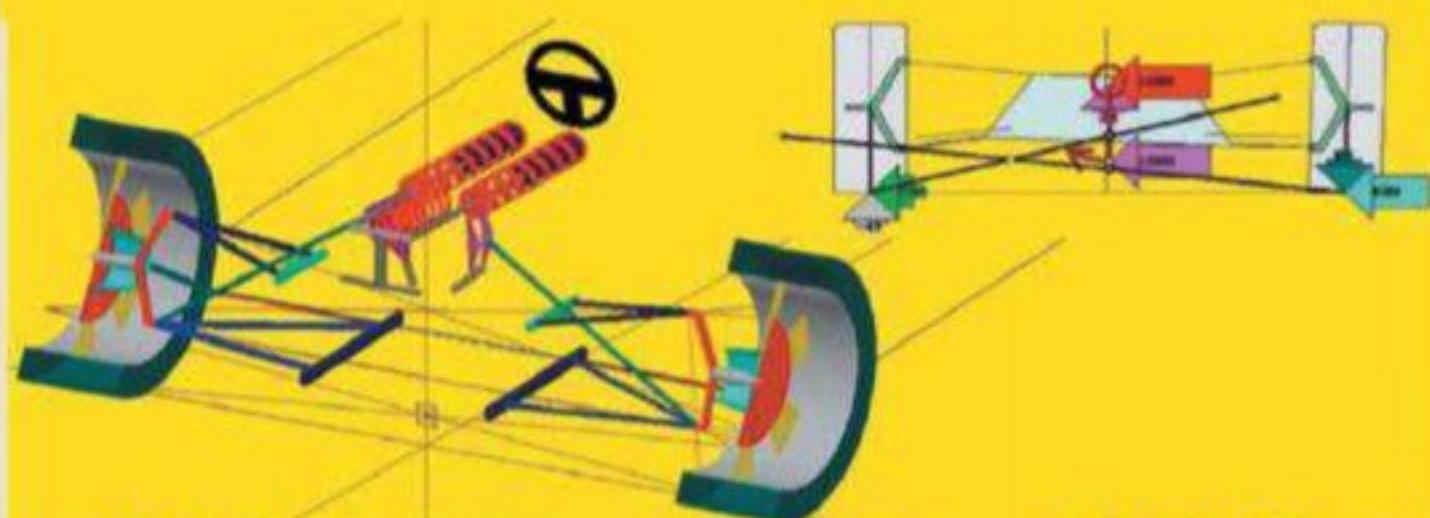
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Contributing Editors

Paul Van Valkenburgh

Technical Consultant

Peter Wright

Contributors

George Bolt jr, Mike Fuller, Simon McBeath, Danny Nowlan, Mark Ortiz, Charles Armstrong-Wilson

Photography

LAT, Gavin D Ireland, Rachel Schadle

Deputy Managing Director

Steve Ross

Tel +44 (0) 20 7901 8011

Email steve.ross@chelseamagazines.com

Sales Executive Tony Tobias

Tel +44 (0) 207 901 8026

Email tony.tobias@chelseamagazines.com

Senior Ad Sales Executive

Lauren Mills

Tel +44 (0) 207 901 8026

Email lauren.mills@chelseamagazines.com

Publisher Luke Bilton

Publishing Director

Sarah Arthur

Managing Director Paul Dobson

Editorial

Racecar Engineering, Chelsea Magazine Company, Liscartan House, 127-131 Sloane Street, London SW1X 9AS, UK

Tel +44 (0) 207 901 8000

Advertising

Racecar Engineering, Chelsea Magazine Company, Liscartan House, 127-131 Sloane Street, London SW1X 9AS, UK

Tel +44 (0) 207 901 8000

Fax +44 (0) 207 901 8001

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Emerging markets

So at in a mini bus crossing Buenos Aires, the two French, two German and one Dutch journalist had the same thought as me – what the hell were we doing in Argentina? The average family car was held together by rust, fortified by a prayer, and in the case of our minibus, a sticker which laid claim to the Malvinas. The Health and Safety Executive was clearly an alien concept to the population and yet here we were, travelling for 34 hours from London to San Luis for the final round of the FIA GT1 World Championship.

On the bill were Lamborghinis, Ford GTs, Nissan GTRs, Chevrolet Corvettes and Aston Martin DBR9s. It would have been less extreme had we arrived with an exhibit from Area 51. We had to travel to Buenos Aires, cross the city in a minibus to the national airport, fly to Mendoza and then drive around 200km back towards Buenos

Aires to get to the track. San Luis has an airport, but the flights are, apparently, prone to being cancelled at short notice if there is a lack of interest.

The door handle of the bathroom fell off whenever you tried to use it, the storms that passed through during the night rattled the aluminium doors that didn't fit and the air con would have woken the dead. The pit lane was a collection of tents, the petrol stations had no petrol and the hire car companies had a fleet that looked as though it had been bought from the local university. From the students.

We all fell in love with the place immediately. Despite it being a new track, it had an old-world charm to it. The magnificent circuit replaced the old road around the lake, and so is open to the public for most of the year, and they drove it like heroes. When the GT1 cars had parked up at the end of the day's racing, the buses and lorries were stopped at either end of the pit straight and a Nissan and Aston Martin performed doughnuts in front of the pits. As fans dangled off the fences to watch the spectacle, a local lad on a motorbike decided to join in the fun, and performed a burnout in the pit lane.

The spectators loved the show, could get close to the cars and the drivers, and the TC2000 Touring Car series was a showstopper. This is one of the top Touring Car

series in the world and, like the BTCC, offers its fans a family day out, an opportunity to get close to the cars, add a touch of glamour to their lives and watch some close racing. The difference is the drivers contesting the Argentinian series are paid more than their counterparts in factory Sportscar racing in Europe and the US and next year they are going to 2.7 litre V8 engines. The TC2000 staff were delighted; next year's car will sound like that Nissan, they hoped. Here, it was easy to follow Stephane Ratel's view that the European circuits are falling out of love with motor racing.

In Argentina, as in Russia, China, and other emerging markets, the government buys the show, and Ratel provides it. The European commentators turn up their noses at Ratel's slide from GT1 to GT3 cars in his World Championship, but the spectators don't care whether

these are GT1, GTE, GT2, GT3 or GT4 cars. The cars that contest the World Championship are those that feature on their childrens' wall in poster form, and that is all that matters.

For the World Endurance Championship (WEC), which announced its calendar a

week later, the goals are clearly defined. The ACO has dropped the Petit Le Mans in 2012 in favour of a race in Bahrain. They tried to drop the event for 2011, but were rail-roaded by Audi (with support from the media, and from Peugeot). Now we have races in Brazil, Japan, Bahrain and China. These are important markets for the car manufacturers who are contesting the WEC. The Brazilian, Japanese and Chinese races should attract the good crowds and bring the atmosphere of a big event.

I lament the loss of the Atlanta race from the WEC calendar, particularly after all the hard work Don Panoz and Scott Atherton put into building it into a must-do race, and hope it will continue to be well supported as a round of the ALMS. I hope, though doubt, that Bahrain proves to be a suitable alternative.

EDITOR

Andrew Cotton

"the spectators don't cars whether these are GT1, GTE, GT2, GT3 or GT4 cars..."

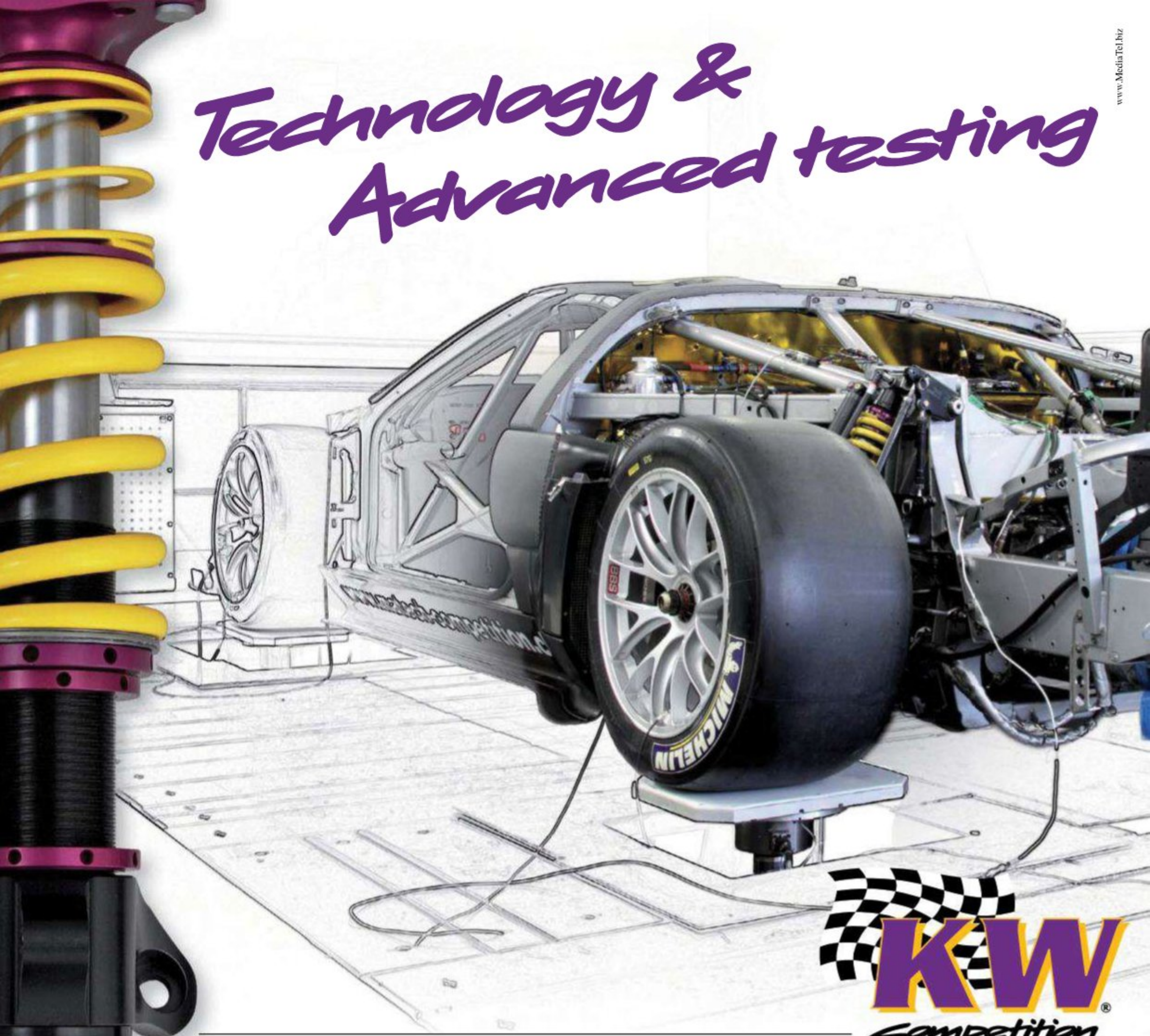
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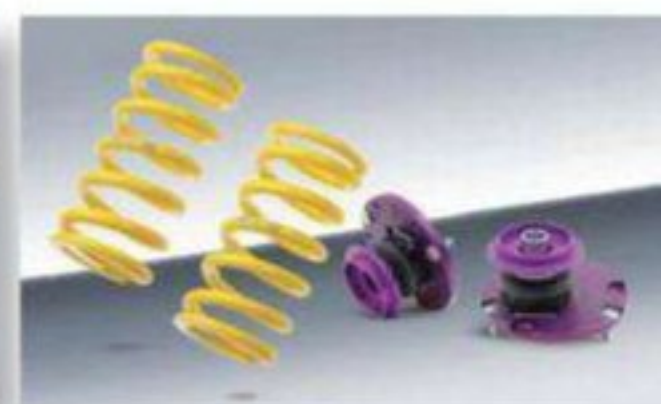
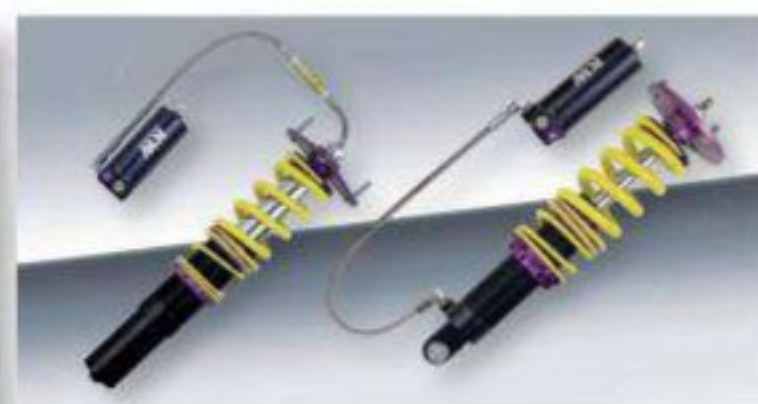
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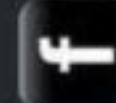


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